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THE JAMAICA EARTHQUAKE (1907).*

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In a paper read before the Society in 1899, I introduced the term "Kumatology" to define the co-ordinate study of the waves of the lithosphere, hydrosphere, and atmosphere; and from 1897 to 1907 I have travelled in search of these phenomena, and presented papers upon some of them to the Society. My first experience of seismic waves on an important scale came to me without seeking when I happened to be at Kingston, Jamaica, on January 14, 1907.

On Thursday, January 10, my wife and I arrived at Kingston on our way back from a visit to the Panama canal, and took up our quarters in the centre of Kingston, at 112, East Street. This hotel, "The Grenville," which was built in the days of slavery, was very substantially constructed of brick, with solid walls 14 inches in thickness for their whole height of two floors, viz. a ground floor and a first floor. The roof, a sloping one, was of wooden shingles, and in the whole structure there was no chimney-stack, fires not being used for warmth in Kingston, and the kitchen being always separate from the dwelling-house. In front, that is to say on the west, of the house a row of massive brick arches formed a verandah to the ground floor, and supported a covered wooden balcony on the first floor. Our own room was a corner one on the first, that is to say the top, floor, having an

* Read at the Royal Geographical Society, December 9, 1907. Illustrated by photographs and diagrams by the author, and discussed at the Research Department, January 17, 1908. Map, p. 360.

outside wall to the south, and another 14-inch brick wall on the west, with two long French windows opening into the balcony.

In this room my wife and I were sitting at half-past three in the afternoon of Monday, January 14, when I heard the noise of an electric car coming from down town, that is to say, from the south. The noise increased, of course, till it was opposite the house, and then just as the rushing should have begun to diminish, there was a sudden and alarming increase of rushing and rumbling sound, accompanied by a savage tearing and rending noise. For a moment I felt no shock and did not realize the cause of the uproar, but my wife, who was sitting nearer the wall, felt a tremor, and, realizing that it was an earthquake, took one quick step to my side and clasped her arms over my head to shield me from the danger of falling masonry, to which she herself thus remained exposed. The next instant the whole house was rocking violently; a fissure opened horizontally near the top of the west wall facing me, and a shower of brickwork fell near the threshold of the door. Had my wife hastened to the door on feeling the shock, she would probably have been struck down at the moment of emergence, as happened in so many cases that day. A cloud of dust and mortar darkened the air, and the solid 14-inch brick wall vibrated to and fro, discharging a cannonade of brickwork into the room. A lump of masonry struck me a numbing blow on the shin. A heavy mahogany wardrobe behind me, but facing my wife the way she stood, executed a clumsy dance, and then pitched over; and the heavy cornice sailed over our heads and struck my wife on the hip in its descent. We were being bombarded both front and rear, but, even had there been any direction in which safety could be found, we were unable to fly, for the timber floor was like quicksand beneath the feet, rising and falling, and opening and shutting, so that we could see into the unceiled room below.

Up to this point one knew that these occurrences might at any instant terminate fatally, but the really awful time came when the house seemed suddenly to lose its cohesion, and we both realized that in another second the floor would give way and the walls fall bodily upon us. Then instant death seemed certain to both of us; but, strange as it may seem, the bitterness of death passed from us both almost instantly after the hope of life had been extinguished. I remember to have felt that such an end, instantaneously and together, was not unmerciful. At this supreme moment, with absolute suddenness, the quaking floor stiffened under our feet, our environment was instantaneously rigid and still, and the noise of the earthquake died away. We rushed from the dark and dust-laden room into the verandah, and down the steps into the sunny garden, where the earth was now quite firm beneath our feet.

We spent the next few days on the lawn by the house, and on the

Thursday we left Kingston for Port Antonio, on the north of the island, the train being crowded with sick and wounded. A week later we sailed for England *viâ* Philadelphia and New York.

During our short and eventful stay in Jamaica we had been much impressed by the generous spirit displayed by the colonists in the face of great financial losses. They scrupulously refrained from exploiting the public misfortune for private profit. We were also much struck with the kindliness which they displayed to one another under very trying circumstances, as well as with the consideration which they showed towards the strangers within their gates.

On May 4, my wife having sufficiently recovered from her injuries, we set out again for Kingston, as I wished to investigate to the best of my ability the cause and effects of the earthquake, by which, and the subsequent fire, twelve hundred persons were killed, and a loss of about £2,000,000 incurred.

On our second visit we went out on board the S.S. *Port Kingston*, which bore the new Governor, and arrived on May 16, about the same time as news reached the island that the Home Government had made a grant of £150,000 to relieve destitution, and guaranteed a loan of £800,000 to facilitate the rebuilding of the city. We found the streets cleared of *débris*, the traction wires set up, and the electric cars running; otherwise everything looked exactly as it had been just after the earthquake, four months previously.

The economic importance of the Jamaica earthquake of January 14, 1907, is due to the destruction of Kingston and its suburbs, and here also the effects of seismic shock upon buildings can best be studied. Viewed, however, from the physical standpoint, the importance of an earthquake is independent of the neighbourhood of cities.

I think that I shall be able to show that the Jamaica earthquake was essentially double-barrelled, so to speak; that Kingston was brought down by one barrel, and that the other barrel was discharged in a thinly populated district, where it consequently did much less damage; but that when we examine the seismic effects in parts of the island distant from either of these foci, we find that they are, on the whole, about as much due to the one part of the double shock as to the other, the charge in the two barrels, so to speak, being about equal. From the physical standpoint, therefore, the Kingston earthquake is not quite the same thing as the Jamaica earthquake.

Thirty seconds is the duration currently assigned to the earthquake at Kingston, but no one really timed it there. At Kellits, about 35 miles north-west of Kingston, Mr. Horn informs me that the earthquake, timed with a watch, lasted 37 seconds, this space of time being divided as follows, viz. 17 seconds shaking, 13 seconds rolling, and again 7 seconds shaking, which finished with a distinct jerk. At Bethany, about 45 miles north-west of Kingston, Dr. Hargreaves informs me that he timed

FIG. 1.—HOUSE IN SOUTH CAMP ROAD, KINGSTON.

FIG. 2.—FIRST-FLOOR DRAWING-ROOM OF HOUSE IN EAST STREET, KINGSTON.

FIG. 3.—THE GARDENS HOUSE, GORDON TOWN.

FIG. 4.—HOUSE AT BUFF BAY.

the earthquake by a seconds-hand watch, and found that it lasted 30 seconds.

I have described the character of the vibrations which I experienced in a top story corner room of a brick house in East Street. These were only in a secondary sense due to the earthquake, the immediate cause being the action of the vibration of the massive walls upon the wooden floor. The movement of the ground was well observed opposite the old Mico, in Hanover Street, by Sub-Inspector Tremlett, and near the south end of John's Lane by Mr. Sullivan. In addition to any jarring or bumping, there was a strong swell, literally a ground swell, running from west to east or east to west. It nearly threw Mr. Tremlett down when he faced westward, but when he turned and faced south he easily kept his balance. Mr. Sullivan, who was running westward out of a falling building, with difficulty kept his feet, although accustomed to heavy weather at sea. He says the west-to-east roll was much stronger than the return roll from east to west. The impression generally received was that these surface undulations were only a few yards from crest to crest, and they certainly succeeded one another several times in a second. The height from crest to crest appeared to be several inches, so that their steepness was very considerable. As far as I am aware, the only instrumental evidence as to the periodic time of the earthquake oscillations is that afforded by the transmitter of the West India Direct Cable in Kingston. I learnt that it had continued to run for a time before the office collapsed, and that the strip of paper had been sent to the London office as a curiosity. I therefore timed the running of the machine in Kingston, and afterwards, in London, was allowed to measure the oscillations of the writing pen as recorded on the strip of paper. There were ten complete north-south-north oscillations in the first two and a half seconds, *i.e.* four per second. The position of the instrument did not permit it to record east-and-west vibrations.

I carefully examined a large number of buildings in Kingston, which is a brick town, to ascertain the line, or direction, and the sense in which walls had fallen. The town is laid out rectangularly, houses facing the four cardinal points, and in the detached houses east- and west-facing outer walls generally fell, while the fall of north- and south-facing walls was an exception, except in the area of greatest damage. Of the east- and west-facing walls many more fell to the east than to the west. In the neighbourhood of North Street, east of East Street, which I examined in detail, I found that of the north- and south-facing walls more fell to the south than to the north. Thus the walls tended to fall, in most cases, towards a little south of east, but in some cases a little north of west. I adopted 15° as a rough estimate of the amount of southing.

I consider that the fall of these walls was due to the action of the

surface waves above described in tilting the walls out of the perpendicular, first in one direction and then in the other, causing them to sway. If the waves were short, as they appeared to be, and as I think they were, the lower part of the wall was thrown very much out of plumb at each half-swing, and a wave of displacement travelled up each wall, so that it became sinuous in form and was subjected to rippling movement.

The mere rapid jarring vibration, which was so marked a feature of the sensations of the earthquake, probably had little effect in overthrowing walls. The north- and south-facing walls, which did not usually fall, were equally exposed to this form of vibration, which seemed to come somewhat steeply from below. These walls were rocked longitudinally by the east-to-west or west-to-east waves (instead of swaying transversely), and the effect was to produce a double system of cracks, often going through the whole thickness of the wall, but not throwing it out of plumb. As the wall returned westward from its eastward excursion, a crack formed, owing to the want of tensile strength in brickwork or masonry, the eastern end of the wall being, so to speak, left behind. On the return vibration in an eastward direction, a corresponding crack opened at the west end, and these cracks often cross each other diagonally, as some of my photographs show. Walls in which cement mortar had been used stood much better than those with only lime-mortar. Kingston lime-mortar is generally of poor quality. The defect of all stone and brickwork, however, in respect to earthquake shock, is want of tensile strength, hence the advantage of reinforcing concrete, etc., by strips of metal, which give a fibre to materials otherwise too brittle. The disadvantage of extra height and of top weight were, of course, abundantly in evidence. Any departure from simplicity of form usually brought about additional damage, Gothic gable and classic cornice being almost equally unsuitable in earthquake countries. In face of these restrictions it seems that architects in earthquake countries must rely mainly upon the skilful proportioning of spaces for the production of artistic effect.*

In making a detailed survey of the amount of damage done in Kingston during our second visit, I was surprised to find how much greater had been the intensity of the shock in the eastern than in the western half of the town, as judged by the effect on similar structures. In the crowded business quarter, where the conflagration took place (and which is mostly situate on the west of the town), the damage was much more *en evidence* because the buildings abutted on the streets, and because the weakly constructed shop-fronts fell out

* Since this was written, an interesting paper on "The Kingston Earthquake and Building in Jamaica," by Sir Charles A. Nicholson, Bart. (read at the Architectural Association on January 10), has appeared in the *Builder* for January 18, 1908, pp. 66–70.

from both sides into the street. This took place even where, as in Harbour Street, the shop-fronts faced south or north. In the residential parts of the city, on the other hand, the damage was to a great extent screened by the trees and garden walls, and also by wooden verandahs and balconies, and the full extent of the damage was only revealed by a closer examination.

Dealing with detached houses of similar construction, one may say generally that west of the burnt area the outer east-and-west walls are out of plumb, but often stand, even in two-story brick buildings, and one-story brick buildings are not overthrown. North of, and as far east as the centre of, the burnt area the east-and-west outer walls of the first, which is the top, story of the two-story buildings fell, and in the east of the city the east-and-west outer walls of both first and second stories fell. In the suburb called Bournemouth Gardens, away to the east of the city, the east-and-west walls of one-story brick bungalows fell. I found that if a line were drawn from the corner of Harbour Street and John's Lane to the corner of North Street and Wildman Street, the unaided eye could at once detect the markedly greater amount of earthquake destruction on the eastward side (Fig. 5).

I sought to obtain a numerical measure of the difference in earthquake destruction in different parts of the city and suburbs by an examination of about 2600 brick pillars of garden walls and gates. The percentage of these pillars which were overthrown by the earthquake is given in the following table:—

PERCENTAGE OF PILLARS FALLEN.

In streets running from north to south (the order in which the streets come is from west to east).	
Princess Street (below North Street) and Orange Street south of the Parade ...	36·0
East Street (north of East Queen Street to the Racecourse)	30·0
Hanover Street (from Harbour Street to North Street)	46·0
High Holborn Street (from Harbour Street to East Queen Street)	69·5
South Camp Road (from East Queen Street to Goodwin Park)	62·0
On roads wholly or partly suburban running north and south.	
Orange Street (from North Street to Torrington Bridge)	17·0
Constant Spring Road (from Cross Roads to Constant Spring Hotel)	4·5
Elletson Road (from Queen Street to Burke's Pen)	53·0
In streets running from east to west (the order in which the streets come is from south to north).	
Harbour Street (from East Street to Fleet Street *)	52·0
Tower Street (from Fleet Street to Paradise Street)	35·5
East Queen Street (from East Street to Paradise Street)	35·0
North Street (from Regent Street to South Camp Road)	9·0
On suburban roads running from east to west.	
Windward Road (from Paradise Street to Bournemouth Gardens)	40·3
Half-way Tree to Papine Corner	4·5

* This part of Harbour Street is close to the shore-line, and not much above sea-level

Thus we see that in Orange Street, below the Parade, and in Princess Street, 36 per cent. of these pillars had fallen, whereas in High Holborn Street and South Camp Road the average was nearly 66 per cent., greater by four-fifths than the former.

In the suburbs the brick pillars generally stand separately, not on walls. They are, therefore, somewhat less liable to damage, and there would not be the same difference of liability according as to whether the road faces north and south or east and west. Taking account of these facts, we may compare the percentage of the fallen pillars on the Windward Road (40·3 per cent.) with that between Cross Roads and

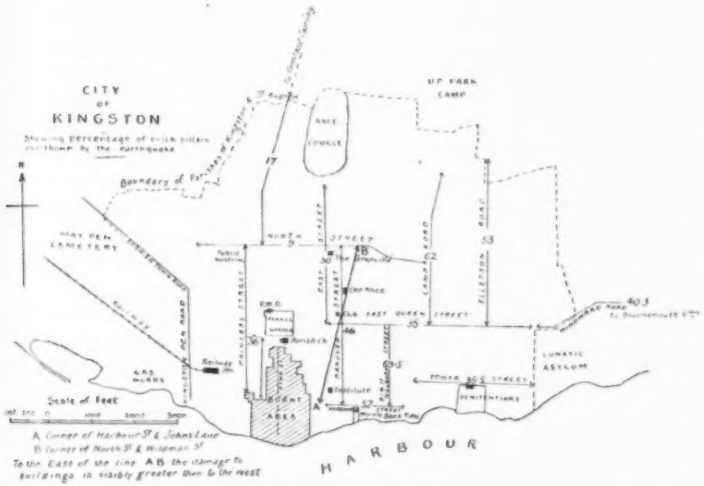


FIG. 5.—PLAN OF KINGSTON, SHOWING PERCENTAGE OF BRICK PILLARS OVERTHROWN BY THE EARTHQUAKE.

Constant Spring (4·5 per cent.), and from Halfway Tree to Papine (4·5 per cent.). The proportion is nine to one. The question may be asked, Is this enormous difference due to the force in the Windward Road being just enough, and that in Lower St. Andrew just insufficient, to overthrow the pillars? I think an examination of the whole table will lead to the conclusion that this is not the explanation of the great difference, and that the *overturning* force of the earthquake on the Windward Road was about nine times greater than on the road from Halfway Tree to Papine Corner.

The overturning force I connect with the short and steep surface waves already described. These appear to be those referred to by Major Dutton,* and called by him epifocal waves. He says of them,

* 'Earthquakes.' By C. E. Dutton (John Murray: 1904), pp. 140 *et seq.*

"There is still a fourth class of earthquake waves, and to the inhabitants of badly shaken regions they are doubtless of the most importance. The normal, the transverse, and the surface waves are seldom seen, though they are more or less felt. The fourth kind are both seen and felt, and are often the most conspicuous and terrifying. They are also the most destructive. They occur only in the epifocal districts of great earthquakes, and never far outside them. . . . Their outward forms, as described by eye-witnesses, exactly resemble flat waves on water. . . . For a long time these motions of the ground were questioned by seismologists, who could hardly believe that such waves could be visible. . . . There is abundant reason for inferring that these epifocal waves . . . have no relation to elasticity . . .; their lengths are too small, their amplitudes too great, and their speed too slow to be dependent upon elasticity. Their lengths, indeed, are not known exactly, but the inference from the accounts given of them is that their wave-lengths range between 10 and 50 metres, and their heights between 5 and 30 centimetres. Their speeds of propagation are even more uncertain, but are almost surely less than 100 metres per second. These quantities do not fall within the range of elastic wave-motion in any such material as the rocks or soil."

Distant seismograms, while they afford the best measure of the total energy of an earthquake, are, in my judgment, not equally appropriate for deducing the overturning force close to a focus. As in the case of storms at sea, but in a greater degree, the magnitude of the distant swell measures the total energy of the waves at the centre rather than their destructive violence. It is the deep-seated part of the wave-motion which travels far; it is the local surface disturbance which does the damage.

I pass on now to describe the distribution of earthquake damage over the island. I myself closely inspected Kingston, Lower St. Andrew, and Buff Bay Town. I also examined the damage to the town of Port Royal, and visited Gordon Town and Port Antonio, besides paying cursory visits to some other places. For the estimate of damage to other places embodied on the map I have relied upon the evidence of others, most of which I obtained direct from eye-witnesses. I have taken great pains to sift the evidence, and to compare where possible the narratives of different persons. The result is far less satisfactory than a complete survey of the island would have been, but it is, at any rate, a much more extensive collection of such data than has hitherto been published.

I received several narratives from persons who, at the time of the earthquake, were in the mountains between Newcastle and Gordon Town, and between Silver hill and Buff Bay; also from persons at Gordon Town and near Castleton. Their narratives indicate that the shock in these situations was quite comparable in intensity to that

in Kingston. Particularly striking was the experience of a party of tourists, who were blocked by a rock fall on the road leading down to Buff Bay, and had to spend the night in the mountains. The after-shocks were numerous, and each was preceded and accompanied by an appalling noise. The severe landslips about Newcastle and on the north side of Silver hill are evidence of as much force as that required to wreck a house, and the complete wreck of the Gardens House at Gordon Town, of which I took a photograph (Fig. 3), indicates, I think, an intensity greater than that at Constant Spring or near Papine Corner.

The damage at Buff Bay, of which I also show a photograph (Fig. 4), was severe, but the stone buildings do not show evidence of having resisted the shock to the same extent as the brick buildings of Kingston. They collapsed instead of being flung to one side, therefore they probably fell at once; for if they had resisted during an appreciable time, the walls would have got up a swing, and then must have been flung either one way or the other. I estimate the force at Buff Bay as about equal to that at Constant Spring, somewhat less than that at Gordon Town, and considerably less than that in the eastern half of Kingston. The damage to the town of Port Royal was about the same as that in the less damaged parts of Kingston.

If we look at the points marked 10 on the folding map, where buildings fell and where new landslips were formed on hillsides, we see that they may almost all be included between two straight lines joining Harbour Head with Buff Bay Town on the eastern side and Port Royal with Enfield on the western side. The general impression received at the time was that the earthquake at Kingston came from the sea, and the fact recorded by the Port Royal pilot, Mr. Hunt, that his boat lying by Lime Cay was struck before Port Royal, and that the shock was followed (in about one and a half minutes) by a surface sea-wave from the south-west, strengthens this idea. Looking at the band of fallen buildings across the island, the idea suggests itself of a seismic wave coming from beneath the sea rather west of south from Kingston and rushing with scarcely diminished force right across the island, the centre of the wave-front passing close to the Penitentiary, the full force of the wave being felt in the eastern half of Kingston and in the eastern suburbs.

When, however, I plotted out the area where single walls fell, a larger tract than that in which the whole of stone, or all the outer walls of brick, buildings fell, I found that the boundaries of this larger area, where the numbers 9 occur (using the Rossi-Forel scale of earthquake intensity),* are not symmetrically placed with respect to the

* I have found it convenient to add to the scale a number 11 for the worst-damaged area.

band already referred to; the area where walls fell reaching far to the east of Kingston in the south of the island, and far to the west of Buff Bay in the north of the island. Now, if the band of the figures 10, that where buildings fell, were due to one wave such as I have described travelling far with scarcely diminished force, then we should expect to find the damage symmetrically disposed on either side of the band except in so far as differences of geological strata may interfere. The comparative immunity of damage at the back of Burlington and of Port Antonio could only be explained then by the supposition that the Blue mountains had in some way cast a seismic shadow. Moreover, when I went yet further into the matter and mapped the buildings which had walls, not fallen, but so severely cracked as to be unstable (Nos. 8), I found that here the distribution of damage accorded with the area of fallen walls, and not with that of fallen buildings. The eastern margin of this area is very far from Kingston on the south, but comparatively near to Buff Bay on the north. The western margin follows a somewhat complicated line, and here for the first time we see a marked influence of the nature of the rock. On the great Limestone plateau the damage to buildings is lessened, but in the Chapelton valley, set in the midst of this plateau, the amount of damage was locally much increased upon strata of other kinds. In the absence of any after-shocks traceable by seismograph to this district, I do not feel that we are justified in assuming that there was here a *centrum* or "focus," in the sense of a place where the stress upon the subjacent rocks exceeded their breaking strain, causing a permanent displacement.

Finally, in mapping out the places reported as slightly damaged, *e.g.* by slight cracks in walls and fall in plaster, I find that this is the case up to the eastern coast of the island, but that the extreme south-western corner of the island comes under the category of undamaged, or No. 6. I may say that I only *record* "undamaged" for towns or groups of houses, among which there are nearly sure to be some of structure such as a strong earthquake would damage. On consulting the map, it will be seen that the western boundary of the places damaged to the extent denoted by 7 runs from west of north to east of south, as do the boundary-lines of 8 and 9, the margins of "serious damage to buildings" and of "fall of walls," respectively.*

On the north of the island, a "tidal wave" of considerable magnitude was observed at Hope bay, Orange bay, Buff bay, Annotta bay, Sheerness bay, Ocho Rios, and St Anne's bay (that at Port Antonio was quite small), this phenomenon commencing near Buff bay on the east, but

* The line was drawn from Montego Bay to Black River, but, a case of damage having been subsequently reported from further west, the line was shifted to the west, while maintained parallel to its former direction, which is required by the general distribution of damage in the neighbourhood, as shown by the numbers on the map.

extending far to the westward. It may have been produced by sand-slides from the edge of the submarine land shelf shown on the map, which is close inshore all along this coast, and outside which lies water of great depth. The "tidal wave" consisted of a recession of water from the shore, followed by its return in waves. At Port Maria this is reported to have occurred a few minutes before the earthquake.

Off the south coast the breaking, "bird-caging," twisting, and burying of the "Direct" submarine cable all along the line from Bull bay to Yallah's point, indicates great sand-slides along that steep submarine slope, where, moreover, large quantities of detritus are continually brought down by the rivers which rise in the Blue mountains.* There is no cable under the Healthshire hills and away along the coast to the west, but the fact of breakage as far east as Yallah's point shows the great effect of the earthquake beneath the sea far to the east of Kingston on the south coast. The eastern boundaries of considerable disturbance at sea are joined by a line running from Hope bay on the north coast to Yallah's point on the south, and the western boundaries from St. Anne's bay on the north to Fort Clarence, where a "tidal wave" was observed, on the south.

Thus again we have boundaries running from east of south to west of north, in conformity with the boundaries of the areas of moderate and slight damage on land, and out of conformity with the boundaries of the area of greatest damage—the area, that is, in which buildings fell.

We shall see presently that the west-of-south to east-of-north direction of the band 10, "fallen buildings," is probably due to the overlapping effect of the western end of a southern focus and the eastern end of a northern focus, and that each focus was probably a long line (not necessarily straight), not a circular area.

The great eastern extension of the moderate intensity of shock on the south of the island we shall see to be due, in part at least, to the eastward position of the southern focus. The great western extension of the area of moderate intensity of shock on the north of the island we shall see to be partly due to the further westward position of the northern focus.

On my arrival in Kingston last May, I found that Mr. Maxwell Hall had published in the *Gleaner* a complete theory of the origin of the earthquake, with a map showing three foci and the direction of vibration of the ground in different parts of the island. This was an abstract of the paper since published under the title of 'Third Report on Earthquakes in Jamaica—the Great Earthquake of January 14, 1907, and the After-Shocks.'† Mr. Hall very kindly offered to show me the

* This detritus drifts westwards before the trade wind, and in June last had already partially repaired a large gap made in the sandy foreshore of Port Royal.

† Government Printing Office, Kingston. 1907.

manuscript of the complete paper, which I studied. On his map the principal epicentre is shown by a circular area 6½ miles in diameter, of which the centre is 7 miles S. 40° E. from the Public Works Department, Kingston; a second epicentre, by a circle 3 miles in diameter, between Enfield and Buff Bay, and a third epicentre by a still smaller circle south-east of Bull Head and south-west of Croft's hill. The axis of the area of greatest intensity, my 10's—marked as VI.'s on Mr. Hall's map—differs very little from that on my map; but the boundaries of the area of serious and slight damage on Mr. Hall's map are concordant with the greatest damage, instead of running, as I have found them, from east of south to west of north.

One of the principal points emphasized in Mr. Hall's report is the contention that the principal vibrations were in all cases at right angles to the direction of progression of the earthquake, and he contends that the reports he received show that in the neighbourhood of each epicentre the vibrations were at right angles to a line joining the place with the epicentre; and that the observations as represented by arrows on the map show a rotation clockwise round each of the three epicentres, and for the far eastern and far western parts of the island a clockwise rotation round the central area where the epicentres are situated. The evidence—contained in the report—on which this important conclusion was based seemed to me to have been treated by Mr. Hall in a manner not quite logical. Thus, to take the case of the observations at Morant Point lighthouse, the evidence is that "it appeared to work from south to north." Now, this evidently relates to the progression of the earthquake, and if the vibrations were transverse they would be east and west, not north and south as shown on Mr. Hall's map. Generally, it seems that either the direction of shaking or the direction of apparent progression has been adopted without discrimination, whereas the very essence of the theory is that they are at right angles to one another. The clockwise rotation, moreover, is obtained by reversing the reported direction south to north (making it north to south) in the case of Morant Point lighthouse, and not reversing the reported direction in the case, *e.g.*, of Annotto bay. I went to Buff Bay as the best means of testing Mr. Hall's theory of transverse vibrations, as well as for the purpose of judging the intensity there. I found, from the careful examination of wrecked buildings, that the line of greatest action was from a little east of north to a little west of south, 15° being the estimate formed of the variation. This is completely at variance with what is required by Mr. Hall's theory, which would make the line of vibration at right angles to what I found from actual observation of fallen walls. At a later date, however, during my visit, Mr. Hall kindly sent me the report of the observations made at Washington * with a

* "The Kingston Earthquake," *Monthly Weather Review*, January, 1907, by Prof. C. F. Marvin.

seismograph consisting essentially of two pendulums vibrating respectively north and south and east and west. Washington lies almost due north from Kingston and Buff Bay. The north-and-south pendulum (that moved by *direct* vibrations coming from Jamaica) began to oscillate first, then the east-to-west pendulum started, and its oscillations (due to *transverse* vibrations coming from Jamaica) were no less than five times greater than the direct vibrations. The author of the note on these observations records the fact as being of great interest, as showing that in this particular earthquake—for the first time, as far as he is aware—the principal vibrations were the transverse waves, those of elastic distortion of the rock, and not the direct waves of compression.

It seemed therefore possible that Mr. Hall's intuition had been correct, although I considered his reasoning faulty and his evidence inadequate; and in the examination of the after-shocks, as recorded by Mr. Brennan's Gray-Milne pendulum-seismograph, I have taken account of the theory that transverse vibrations predominated, as well as of the theory that direct vibrations predominated in Jamaica. The following table shows the after-shocks recorded on the seismograph which Mr. Brennan re-established on January 29. He kindly gave me this list for publication, as well as a description of his instrument, and allowed me to inspect the original records, a series of elongated oval

RECORD OF AFTER-SHOCKS REGISTERED BY PENDULUM SEISMOGRAPH AT THE OFFICE OF PUBLIC WORKS DEPARTMENT, KINGSTON (ARRANGED BY THE AUTHOR FROM MANUSCRIPT KINDLY SUPPLIED BY MR. J. F. BRENNAN).

No. I. SERIES (*greater in average intensity at Kingston—fewer in number* (13)—*comprised within a smaller arc*).*

Coming from	Maximum horizontal movement.	Date.	Hour.
	Inch.		
S. 85° E.	0·096	April 13	7.8 a.m.
S. 82° E.	0·003	„ 24	7.25 p.m.
S. 75° E.	0·023	March 22	6.41 p.m.
S. 75° E.	0·013	„ 27	8.56 a.m.
S. 74° E.	0·002	February 3	12.05 a.m.
S. 73° E.	0·006	January 29	1.06 p.m.
S. 71° E.	0·010	February 5	10.59 p.m.
S. 70° E.	0·027	„ 22	8.43 a.m.
S. 66° E.	0·004	„ 17	9.50 p.m.
S. 65° E.	0·009	January 29	9.20 p.m.
S. 44° E.	0·007	May 3	11.10 a.m.
Mean S. 71° E.	0·018	—	—
N. 85° E.	0·012	August 22	4.25 p.m.

* The solitary shock from S. 44° E. being excepted.

No. II. SERIES (*less in average intensity at Kingston—greater in number* (25)*—spread over a larger arc*).

Coming from	Maximum horizontal movement.	Date.	Hour.
	Inch.		
N. 2° W.	0·002	March 1	5.55 a.m.
N. 1° W.	0·003	„ 11	1.50 a.m.
N. 1° W.	0·003	April 14	10.30 p.m.
N.	0·004	June 8	4.7 p.m.
N.	0·002	„ 29	2.11 a.m.
N.	0·002	Sept. 10	5 a.m.
N. 3° E.	0·003	February 27	11.40 p.m.
N. 3° E.	0·002	March 17	7.45 p.m.
N. 3° E.	0·002	„ 20–21	Midnight
N. 3° E.	0·002	April 9	9.35 p.m.
N. 4° E.	0·002	March 19	6.10 a.m.
N. 5° E.	0·006	February 11	5.30 p.m.
N. 6° E.	0·007	„ 11	12.44 a.m.
N. 8° E.	0·003	„ 22	6.15 p.m.
N. 13° E.	0·003	February 26	8.46 p.m.
N. 15° E.	0·023	April 9	2.40 a.m.
N. 17° E.	0·014	March 23 *	11 p.m.
N. 17° E.	0·007	„ 31	7.45 p.m.
N. 20° E.	0·002	July 28	4.36 a.m.
N. 25° E.	0·004	March 14	11 p.m. ?
N. 40° E.	0·007	„ 7	6.10 a.m.
N. 45° E.	0·002	September 11	8.52 a.m.
N. 45° E.	0·010	October 3	4.9 p.m.
N. 46° E.	0·003	February 18–19	Midnight ?
N. 49° E.	0·007	March 5	9.55 p.m.
Average intensity	0·005	—	—

The direction of the after-shock of June 13 has been omitted. The maximum horizontal movement was 0·035 inch.

Directions of after-shocks registered by Mr. Maxwell Hall's seismograph at Chapelton.

S. 74° E.	—	June 13
N. 82° E.	—	„ 29

curves scratched by the oscillating needle in the lampblack coating of a horizontal glass plate. Mr. Brennan's work is of capital importance in the elucidation of the earthquake of January 14. All the records present this feature in common—that the greatest excursion takes place on one side of the centre, being apparently the first tilting of the building to which the instrument is attached. The curves, as has been said, are long ovals, so that there is no difficulty in determining with fair accuracy the line of greatest backward and forward tilting of the ground or line of principal vibration.

* At Buff bay, the strongest shock since January 14; also somewhat severe at Annotto bay.

As will be seen from the table, these after-shocks belong to two principal groups: one in which the vibrations are along lines rather south of east to rather north of west, and *vice versâ*; and another more numerous group of shocks, generally less violent at Kingston, whose vibrations are along a line from east of north to west of south, and *vice versâ*. The principal excursion of the former group was westward of the point of rest of the pendulum, the principal excursion of the latter was south of the central point.

Now, the general line of vibration of the less numerous set of after-shocks, which were the stronger *at Kingston*, was the same as the line in which buildings chiefly rocked in Kingston, and the line in which the walls fell. This is one of the most salient and well-established points relating to the earthquake, and I have no hesitation in stating, as a sure deduction, that these vibrations were repetitions of those which destroyed Kingston. Were they transverse or direct? If the former, as the Washington observations suggest and as Mr. Hall's scheme requires, then they came from west of south or from east of north.

Observers in Kingston on January 14 agreed that the path followed by the destruction was from the seaward, not from landward, from a southerly, not a northerly direction. On the theory of transverse vibrations, therefore, the central line of this set of after-shocks (and therefore, by inference, of the shock which destroyed Kingston) was S. 19° W. or thereabouts from the P.W.D., Kingston (Fig. 6). The distance at which the focal line (due to an originating fault, to adopt the usual hypothesis) would be situate cannot be accurately determined, but as soundings were unchanged for 5 nautical miles south of Port Royal, along the south channel, I should provisionally select a position between this point and the southern break in the Panama cable, which is shown on the map.

If this be really the direction from which the stronger but less numerous set of after-shocks came, then it follows as a necessity that the other group came from a little south of east or a little north of west for the P.W.D. at Kingston. The rapid falling off in intensity of the earthquake to west of Kingston negatives the latter alternative.*

Drawing the lines eastward as in Fig. 6, we see that several of them pass through the subsidences recorded by Mr. Charlton Thompson, harbour-master, in the eastern part of Kingston harbour. These subsidences of some fathoms near Rock fort, and that at Harbour head,† are

* See, however, *Pop. Sci. Monthly*, vol. 70 (1907), pp. 385-403: Prof. Chas. W. Brown, "The Jamaica Earthquake."

† Extract from the *Jamaica Gazette*, February 14, 1907. "I surveyed the foreshore from the wharves up the northern shore of the harbour to Harbour Head. The soundings off the wharves and up to eastward of the Lunatic Asylum have not been materially altered, but close to the shore from Rockfort Gardens and under the

the most considerable physical changes recorded as the result of the earthquake, and they are but a short distance from Kingston. The directions of some of the shocks are also consistent with additional origins of disturbance near Bull bay, not far from which there is a suspected case of a change of soundings amounting to many fathoms.

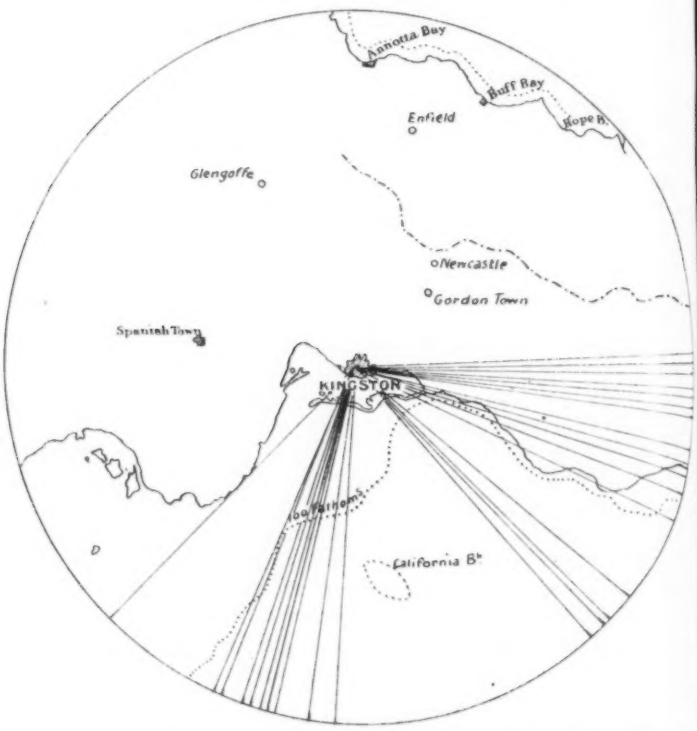


FIG. 6.—DIRECTIONS FROM WHICH THE AFTER-SHOCKS CAME, ON THE THEORY OF TRANSVERSE VIBRATIONS.

If Kingston were wrecked by transverse vibrations, then the first and by far the most important focus of the Jamaica earthquakes was S. 19° W. of Kingston, probably a good many miles out at sea; and the second focus was of merely local importance, mostly situate near the

base of Long mountain there is in places considerable subsidence, also at the eastern edge of the Palisadoes, where I got 4 fathoms of water over mangrove bush which had hitherto been above water; here there are many cracks and fissures in the sand. The soundings further from the shore and through the centre line of the harbour are practically unaltered.

"(Signed) CHARLTON THOMPSON,
"Harbour Master."

coast of the eastern part of Kingston harbour. This theory is in accordance with the Washington observations, and accounts for the distribution of the area of fallen buildings, if we assume that the earthquake wave travelled far with slight diminution of intensity in its line of direct propagation. On the other hand, it is out of accord with the general distribution of boundaries of moderate and slight damage in the island.

Towards the end of my second visit to Jamaica Mr. Maxwell Hall erected a pendulum seismograph at Chapelton. It recorded the considerable after-shock of June 13, vibrating in a line S. 74° E. and N. 74° W. This could not be due to transverse vibrations from either of the positions which I have deduced for the foci on the basis of that theory. Unfortunately, Mr. Brennan's seismogram of this shock was rendered imperfect by the needle having left the plate. I was unable to agree with Mr. Brennan's opinion that the vibrations were from east of north to west of south, and thought they were from south of east to north of west. Up to the time of writing only one certain cross-bearing from the records of both seismographs has been published, viz. that of the after-shock of June 29, very slightly felt at Kingston. The direction at Kingston was north to south exactly; that at Chapelton was S. 82° W. and N. 82° E. On the theory of transverse vibrations, these two records are hopelessly at variance, as can be seen from an inspection of the map; but on the theory of direct vibrations they are in harmony, and their point of radiation is shown by the position marked A upon the map. The instrumental evidence, therefore, though not abundant, is clear and precise in its indication that the vibrations of the after-shocks were direct. It is singular that Mr. Hall should have assumed this to be the case all along, while considering the main vibrations of the principal shock to be transverse. If any conclusions as to the original shock are to be drawn from the after-shocks, it can only be because they are repetitions of the original, and such I shall throughout assume them to be.

Reasoning now on the supposition that the vibrations of the after-shocks were direct, not transverse, we will proceed to deduce, as nearly as the data allow, the positions of the foci of the earthquake, giving due weight at the same time to the distribution of damage in the island.

As I have said, the set of after-shocks which vibrated from S. 15° E. to N. 15° W. are certainly repetitions of the shock which overthrew Kingston; they were the strongest after-shocks *at Kingston*, and the vibrations coincide in direction with the fall of buildings there.

The greatest, and apparently the first, excursion of the needle was to the west,* but the distribution of intensity shows that the centre of

* This fact, combined with the experience of people in the streets of Kingston on January 14, 1907, suggests that the tilting of the ground was first a slow heeling over to the west, followed by a sharper subsidence, causing a more sudden heeling to the

activity could not have been west of Kingston. Therefore, on the direct theory, the shocks came from the eastward, and their directions are shown in Fig. 7. Several of them pass through the positions of the subsidences in the east of the harbour, which were established by Mr. Charlton Thompson; so that the function of these subsidences, and of the occurrences off Bull bay, as indications of a probable focus, is indicated equally well on the direct and on the transverse theories.

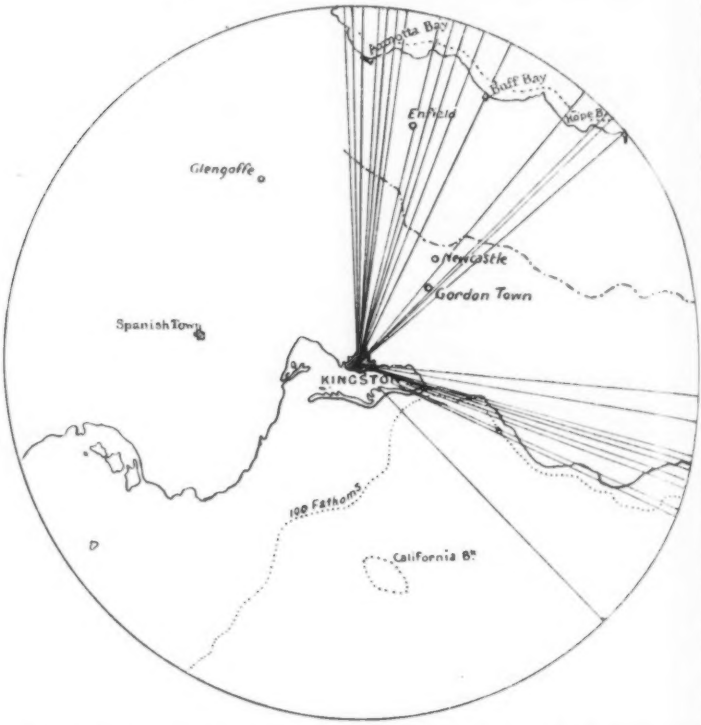


FIG. 7.—DIRECTIONS FROM WHICH THE AFTER-SHOCKS CAME, ON THE THEORY OF DIRECT VIBRATIONS.

We have seen that, on the direct theory, in the case of the first set of after-shocks the direction of progression must have been from east

east. The process of subsidence at the epicentre may possibly have been as follows, viz. first a swelling up, as the packed rock-material at and near the surface assumed a more open order, and then a subsidence into the new positions. Such is the process which Sir George Darwin observed in his experiments upon landslips, the explanation of which is provided by Prof. Osborne Reynolds' discovery of the property called *dilatancy*.

to west, *i.e.* towards the direction of greatest travel of the needle. In the second set of after-shocks the needle moved more to the southward, and they must be assumed, therefore, to have originated to the northward. The lines of their direction from Kingston are shown upon Fig. 7. There are no subsidences or faultings yet reliably recorded on land as a result of the great earthquake to show how far distant from Kingston along these lines were the foci, but we have, in the case of the after-shock of June 29, the cross-bearing from Chapelton, which cuts the direction from Kingston at the position shown on the folding map by the letter A. Some approximation to the probable distance of other points of origin of disturbance are afforded by the map of distribution of damage.

This direct theory of vibration of after-shocks is demanded by the definite, though scanty, evidence of the directions of vibration from Chapelton, but the argument is strengthened by the way in which the distribution of earthquake damage throughout Jamaica is accounted for by this arrangement of foci, and are, on the other hand, violated by the arrangement of foci required by the transverse theory.

Thus on the transverse theory (Fig. 6) the Jamaica earthquake was mainly due to a focus which sent out *fewer* after-shocks than the minor focus. The after-shocks which were felt most strongly at Kingston came from the more distant centre; the more numerous set came from a relatively short line of country and the less numerous from a long line. Finally, the after-shock of March 23 was felt more severely at Buff bay than at Kingston, although, on the transverse theory, more distant from the former place. Several of the early after-shocks recorded before the erection of seismographs were felt as strongly at other places as at Kingston, *e.g.* the shock of Tuesday, 15th, about mid-day, which brought down a cracked wall at Port Antonio on the north east of the island. These facts are not satisfied by an arrangement which makes the main part of the Jamaica earthquake come from several miles south, and somewhat west, of Kingston.

Again, we see that on the positions which must be assigned on the "direct" theory of after-shocks, in harmony with the distribution of damage, probabilities are further satisfied in that the after-shocks more strongly felt at Kingston are those of the group originating near that place. Of the northern set of after-shocks, those felt most strongly at Kingston probably originated nearer to Kingston, and are probably repetitions of the shock which was principally responsible for the damage at Gordon Town and Newcastle.

The northern set of after-shocks, which are the more numerous, come also from a longer line of country. The original shock, of which they are repetitions, may have been equal to the shock which wrecked Kingston, and its central position in the island accounts for the fact

that the general distribution of damage seems to depend as much on the northern as on the southern focus.

Fig. 8, which shows the direction in which walls and buildings fell, lends support to the theory of a southern focus near the coast, and northern focus near the centre of the eastern portion of the island, assuming, as I shall now proceed to do, the correctness of the direct "theory" to be established. The directions for Kingston, Port Royal, Halfway Tree, Stony Hill, Constant Spring, and Buff Bay were determined by myself. The Kingston direction is, of course, the best established, being determined from a larger number of buildings. The directions

FIG. 8.—ARROWS SHOWING FALL OF BUILDINGS.

for places in St. Thomas are mostly from observations by Mr. Pearson, who, at the request of Mr. D'Aeth, Assistant Director of Public Works, made a tour of inspection with the special object of investigating this point for my information. In Kingston, as I have made clear, the buildings fell towards the probable centre of local disturbance, near the shore of the eastern harbour, and I shall assume, therefore, in absence of contrary evidence, that the same rule was followed elsewhere. It will be found that in Lower St. Andrew and in St. Thomas the directions converge to an elongated ellipse, the axis of which is roughly from Rockfort to Yallah's Salt Ponds; but that, as far as the evidence goes, the buildings in the triangle—Newcastle and Silver hill, Glengoffe and Buff Bay—fell towards an area, the shape of which

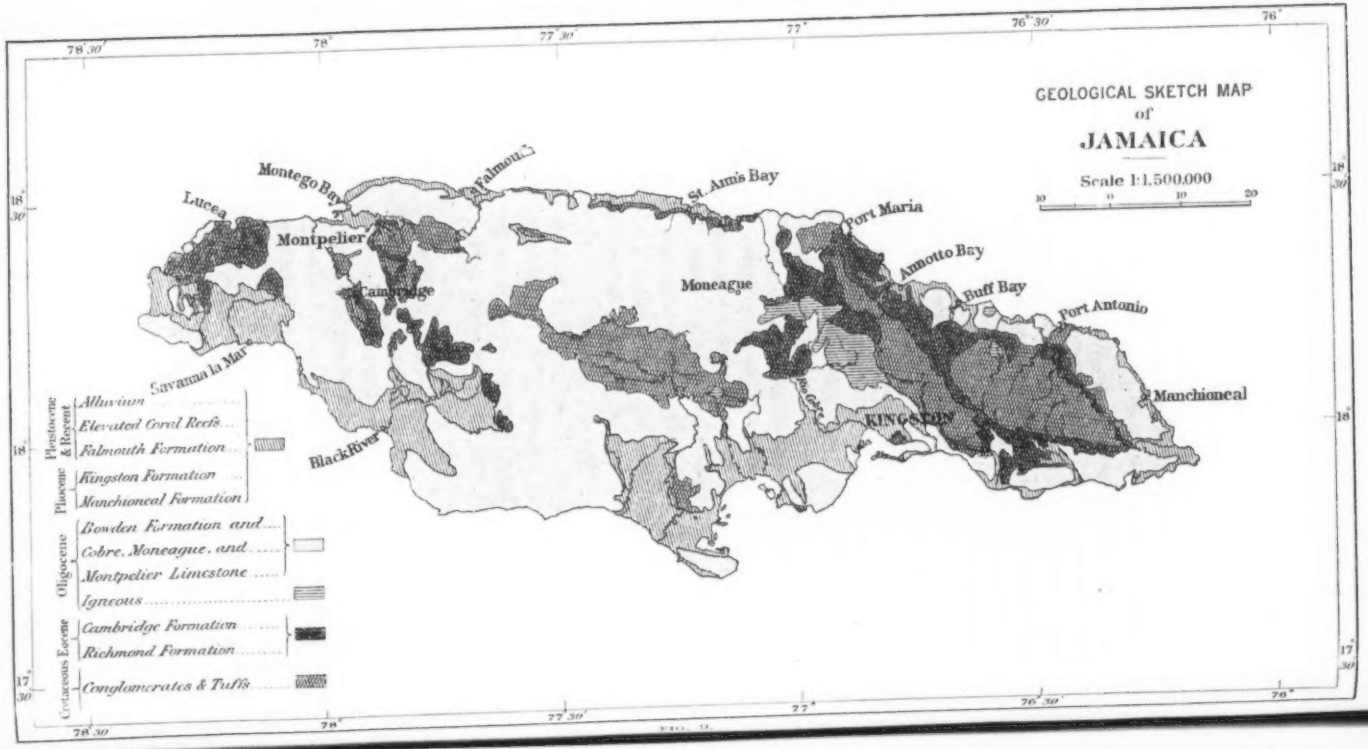
remains at present indefinite, within that triangle. The observations here are, however, less numerous and less reliable than in the south. Situated within the same triangle, at the position marked A upon the map, is the converging point of the directions of the after-shock of June 29 recorded both at Kingston and Chapelton. Assuming the seismograms to be accurate, this gives the position of almost the most westerly point of the northern origin of after-shocks, which I shall assume for the purpose of this paper, to be the same as the northern origin of the earthquake. It is situate in the valley of the Ginger river, on the southern side of the western portion of the central mountains on the "Metamorphic" formation of Sawkins' * map, which is the "Conglomerate and Tuffs" of Hill's † map.

If the focus of the earthquake be related in position to the surface boundaries of the geological strata, then (reasoning from the distribution of damage without reference to the above radiant point) it appears not improbable that the cause of the northern part of the earthquake was a relative movement along the north-west to south-east line of junction of the Carbonaceous shale and the Metamorphic series (using Sawkins' terms), that is to say, the Richmond formation and the Conglomerates, using R. T. Hill's nomenclature. That such disturbance has taken place in the past is indicated by the fault at this junction, which is shown by Sawkins not far from Enfield, and bearing north about 12° east from Kingston. Mr. Hall has already drawn attention to the existence of this fault in connection with the earthquake. Unfortunately, it has not so far been inspected, so that we have no evidence that there has been a further shift. The considerable shocks from north 40°, 46°, and 49° east, Mr. Hall traces to the fault on the Spanish river, but in this case there is not only an absence of direct evidence, but the indirect evidence of the distribution of damage does not support the supposition, for scarcely any damage has been reported from this region of the island.

The band marked 10 on the map—that in which buildings were overthrown—crosses the island from north to south with a cynical disregard for variations of geological strata (Fig. 9). This fact is probably due to its not being really the track of a single seismic wave, but to the presence of a second centre of disturbance halfway across the island. When, on the other hand, we examine the distribution of damage beyond the neighbourhood of the two regions of original disturbances, we find one well-marked connection with the arrangement of rock, viz. that the eastern boundary of the great White Limestone plateau is generally the western boundary of severe damage. This seems to be due to a

* 'Reports on the Geology of Jamaica,' by James G. Sawkins, F.G.S. (Mem. Geol. Survey). 1869.

† 'The Geology and Physical Geography of Jamaica,' by Robert T. Hill. Cambridge, Mass., U.S.A. 1899.


GEOLOGICAL SKETCH MAP
of
JAMAICA
Scale 1:1,500,000
10 0 10 20
78° 30'
78°
77° 30'
77°
76° 30'
76°
18° 30'
18°
17° 30'
17°
Montego Bay
Falmouth
St. Ann's Bay
Lucea
Montpelier
Cambridge
Moneague
Port Maria
Ahhotto Bay
Buff Bay
Port Antonio
Manchioneal
Savanna la Mar
Black River
KINGSTON
Pleistocene & Recent
Alluvium
Elevated Coral Reefs
Falmouth Formation
Pliocene
Kingston Formation
Manchioneal Formation
Oligocene
Bowden Formation and
Cobre, Moneague, and
Montpelier Limestone
Igneous
Cretaceous Eocene
Cambridge Formation
Richmond Formation
Conglomerates & Tuffs

mechanical reason, viz. that foundation on this resilient rock helps to make a building earthquake-proof. Thus Higgin town on the Limestone plateau was undamaged, whereas buildings on deep alluvium at Cave valley and Greenock close by were wrecked. In the east of the island hardly any damage was reported from the limestone region of the John Crow mountains. In St. Thomas and Portland some of the damaged houses, which a small-scale geological map would indicate as being on

FIG. 10.—EXTENT OF THE JAMAICA EARTHQUAKE AS A SENSIBLE SHOCK (ROSSI-FOREL SCALE).

the White Limestone, are, in fact, situate on narrow bands of alluvium close to rivers.

The shocks from the two foci of the earthquake of January 14 were practically simultaneous, so that they must be ascribed to a common cause, but what was the physical connection between the two areas, causing them to be simultaneously affected, has not yet been discovered.

The earthquake was felt in Haiti (Fig. 10), at a distance of 173 geographical miles from Newcastle, but was not perceptible to human senses at a distance of 250 miles in Haiti, or in Grand Cayman island,

260 miles to the west. The great strength of the shock near the two foci, combined with the comparatively small radius of perceptible shaking, suggests that the earthquake was not deep seated.

In concluding this outline of my investigation of the Jamaica earthquake of January 14, 1907, conducted at my own expense, and without special facilities for prosecuting the work, I will venture to state what I think might properly have been done by the Home Government in this matter. A commission of three should have been despatched at once to the island, composed of a field geologist, an expert in building construction, and an hydrographer. The neighbourhood of the coasts should have been re-surveyed, a complete record made of all damage to buildings, simple seismographs set up in different parts of the island, and an exploration made for new faults, or movements of old ones, particularly in the somewhat difficult country of the central part of the eastern third of the island, which is at the same time mountainous and in many places thickly wooded. Three months would probably have sufficed for the observations, and another three months for preparing the report. The guidance which such a report would have furnished for selection of methods of building, and perhaps of sites for houses, in Jamaica, would in itself have more than repaid the expense, and the report would have been a valuable guide in other parts of the empire which are situate in seismic areas.

I am indebted to many persons for information, and desire to acknowledge my obligations to Mr. J. D'Aeth, Mr. J. F. Brennan, Mr. Frank Cundall, Mr. Maxwell Hall, the Rev. F. L. King, Sir Charles Nicholson, Bart., Mr. Charlton Thompson, and the officials of the West India Direct, and of the West India and Panama Telegraph Companies.

Scale of Earthquake Intensity employed for the Folding Map and for Fig. 10.

11. All outer walls of brick houses built with lime mortar overthrown. Complete collapse of stone-built country houses.

10. Outer walls of upper story of brick houses built with lime mortar overthrown. New landslips on hillsides. New springs.

9. Some brick and stone walls fallen. Old landslips enlarged.

8. Cracks in walls sufficient to render them insecure.

7. Slight cracks in walls and fallen plaster.

6. No damage to buildings, but shock recorded as of a severity unusual in Jamaica.

5. Moderate shock, felt generally by every one.

4. Feeble shock, felt by persons in motion.

3. Very feeble shock, but strong enough for the direction or duration to be appreciable.

2. Extremely feeble shock felt by a small number of persons at rest.

1. Microseismic shock, felt by an experienced observer.

The arrangement of localities according to the class of damage described under readings 11 to 6 was made by the author solely from the consideration of facts and

circumstances in Jamaica, but it was found that the scale was concordant with that of Rossi-Forel, except that in the latter the number 10 does duty for both the 10 and 11 of the author.

The descriptions for the numbers 5 to 1 are extracted from the Rossi-Forel table, as given by Dutton in his book on 'Earthquakes' (Progressive Science Series). One of these numbers (3) corresponds with the intensity observed in Eastern Cuba and in the western peninsula of Haiti.

The PRESIDENT: It is with sincere pleasure that we shall once again hear Dr. Cornish address us upon the subject which he has made especially his own, which he has most appropriately christened Kumatology, or the science of waves, and to which he has devoted great ability and most careful attention. During the last ten years Dr. Vaughan Cornish has frequently addressed us (and has also contributed valuable articles to our *Journal*) on that interesting subject, and has set before us his observations and his deductions on the action of waves in the atmosphere, in the hydrosphere, and in the lithosphere, or, in other words, in gaseous, liquid, and solid matter. Under the last head I, of course, include sand-dunes, sea-beaches, and snow-waves. Many of you will remember that Dr. Vaughan Cornish visited the Nile for the purpose of examining the sand-waves of the desert which border upon the valley and delta of the river, and that he also went to Canada to investigate the phenomena of snow-drifts and snow-waves; but I do not for a moment suggest that he went to Jamaica in order to examine the action of earth-waves, which he encountered there in a formidable shape, and which he is going to describe to us to-night. As regards his investigations in the hydrosphere, perhaps the most interesting that he has laid before us was in relation to that remarkable tidal wave in the river Severn, which is known as the Severn bore. To those who have not followed Dr. Vaughan Cornish's investigations as a whole, I would recommend the perusal of an abstract, which appeared in our *Journal* for June, 1899, of an address which he had given us a few months before on his new science of Kumatology, and in which he dealt generally with the subject. One great merit in Dr. Vaughan Cornish's observations, if I may venture to say so, has been that he has fixed those observations, wherever it has been practicable, with the aid of a photographic camera, and even the Jamaica earthquake did not make him forget that valuable companion. I am quite sure you will understand that it would be inappropriate for our lecturer to attempt to-night to enter into the more technical sides of his very interesting subject. He is reserving these for an address to the Research Department of our Society, where we can have a full discussion, that Department being, as you know, open to all Fellows of the Society, as well as to eminent and recognized scientific observers from outside. I will now invite Dr. Cornish to give his address.

Dr. STRAHAN: I must confess to having had at first some misgivings as to the propriety of bringing an account of an earthquake before a Society whose function is the study of geography, but I was somewhat reassured when I came to reflect that earthquakes are important factors in the determining of coasts, in the alterations of the level of the land, and in the formation of mountain chains. We have heard a little, and we hope to hear a great deal more, upon the cause of this earthquake. The fashion now, if I may use the expression with regard to scientific hypothesis, is to find an originating fault for every earthquake, and I am bound to state that in my opinion that theory has been sometimes forced beyond its legitimate limits. I do not mean to say that a fracture, such as a fault along which the strata have been misplaced, may not have been the cause of many earthquakes, but I think that the wrong fault has been credited with the mischief in several cases.

In the first place, many of the faults which are shown upon our geological maps, and which are familiar features to all geologists, are faults of very ancient date indeed. They are defunct in the sense that they came into existence when the world was young, and that they have been inactive during many geological ages. Unless there is some evidence of renewed movement along such faults, it is hardly fair to credit them with having caused the earthquakes of to-day. As another example, I may mention a case of a somewhat different kind which took place recently. It will be within your recollection that in South Wales, some few months ago, there was an earthquake of considerable intensity. An account of it was published, and the isoseismic lines were drawn with what seemed to me an astonishing regularity and certainty. The originating fault also was laid down exactly, the towns by which it passed were named, and, in fact, the account of it as published was circumstantial and bore upon it the aspect of truth. But it so happened that the region which it was supposed to traverse is honeycombed with old coal-workings, and in that region every fault which exists is perfectly well known: I am able to state as a fact that no such fault exists along the line described. One comment I should like to make, and I think it has occurred to everybody in this room. We always have been given to understand that an earthquake is one of the most terrifying experiences through which a man can pass, and I think there is nothing that we have seen or heard to-night to dispel that idea. The obligation under which we are placed by one who has passed through the ordeal, and has been able to preserve for us a reliable record of what took place during that wonderful moment and after, is great.

Sir Charles Nicholson: I did not come at all prepared to say anything to-night. I went out to look at some of the buildings, with a view to suggesting how they should be reconstructed. From the architect's point of view, the old buildings in Jamaica were constructed without much foresight as to the possibility of earthquakes. Two hundred years ago there was a prosperous town at Port Royal, which is the spit of land now enclosing the harbour. This town was shaken down by an earthquake, and the people of Port Royal went and settled at Kingston. Having got to Kingston, they made up their minds that they were perfectly safe; so they proceeded to build rather handsome Queen Anne buildings with good thick walls, but not very choice materials. They never thought that the earthquake was coming, and it didn't come for two hundred years; at last it did, and many of the buildings came down. But there are some buildings in Kingston which did not come down, even in the central part of the town. In one instance I think Dr. Vaughan Cornish may bear me out. He probably noticed the tram company's power-station. That is a building which has no partitions or internal supports of any kind, it is a brick and cement building. Other brick buildings in Kingston, such as the parish church, were built with very poor lime-mortar, and these buildings collapsed, at any rate in the parts of the town which were most affected by the earthquake; but the buildings did not collapse if they were built in cement-mortar. By the quay, again, there is a large customs shed, a considerable-sized room, about as long as this theatre, unsupported by buttresses or columns or internal walls, but it was built of cement concrete, and stood without a crack. There is only one other thing I should like to say, and that is, that before going out to Jamaica, and on the way out, I read a good deal that had been written by Prof. Milne about the behaviour of arches, and I was surprised to see how very many arches in Jamaica stood without any serious injury; there seems to be an elasticity in arched construction, and an arch gives from right to left, and so minimizes the shock.

Mr. Oldham said that, as he had not expected to be called upon to speak, he could only mention some of the various ideas which passed through his mind as he listened to Dr. Cornish's paper. He would put first the fact that this Jamaica

earthquake, although, as Dr. Cornish remarked, a great earthquake, was not a very great earthquake. It did not compare, for instance, with the 1897 earthquake in India, or, to come nearer to them in time, with the Valparaiso earthquake, which caused vastly greater damage. And in the minor question of the interruption of amusements, Dr. Cornish had mentioned that four months elapsed before there was a dance in Kingston; but the Valparaiso earthquake took place more than five months before the Jamaica one, and he had been informed only a day or two ago that the after-shocks were still frequent, and severe, so much so that nobody had ventured to suggest the possibility of a dance. This earthquake had suggested some very curious seismological problems. When the first accounts came of the earthquake, it appeared to be one of those very localized earthquakes, like that of Casamicciola in 1883, which are extremely intense over a small area, and are hardly felt outside that small area. Later on accounts came in which showed that this interpretation needed to be modified; cables were fractured, not close in shore, but at distances of 5 and 8 miles away from Kingston, and Mr. Maxwell Hall's report, as well as Dr. Cornish's account, showed that the earthquake was not so localized in Jamaica as at first appeared. Moreover, the long-distance records in Europe and elsewhere were very insignificant, in comparison with the magnitude of the earthquake at its centre, or what is called the magaseism. There was another word which had been introduced of late years, namely, "teleseism;" though originally it meant merely a long-distance record of an earthquake, he was not sure that it did not represent more than that, or that the disturbance registered at a distance from the origin of an earthquake was the same thing as that felt on the spot. It is quite certain that many great macroseims give rise to very small teleseisms, and he was investigating the possibility of the converse. This was difficult to establish, as it was only for the last few years that records were available to work on, but the disturbance represented by the teleseism seemed to be distinct from the superficial disturbance, or macroseism, which causes damage near the origin. He would not discuss Dr. Cornish's theory of the origin of the earthquake, because that subject would come up again at a future meeting. Finally, with regard to the question of damage to buildings and earthquake construction. This had been studied and reported upon in the case of several of the great earthquakes which had lately been experienced, and the one thing that had come out prominent above all others was that, if you wanted to make an earthquake-proof building, you must put in sound material and good construction. In San Francisco not one soundly built building was seriously damaged. In Calabria, where so many lives were lost and so many buildings were destroyed, Prof. Riecò, in his report to the Italian Government, attributed the greater part of the damage to bad construction and faulty material. According to him, these were rarely good, occasionally passable, often bad, but usually sinful; and, to judge from Dr. Cornish's photographs, it seemed that very much the same might be said of Kingston. Like the last speaker, he had been struck by the standing of the arches, but was not sure that the explanation offered was the correct one. An arch was in itself the very worst form of construction possible to resist an earthquake, but an arch could not be built of bad material and bad workmanship. Where arches were put into a building, good material and good workmanship were used, whatever might be done in the rest of the wall, and so when the earthquakes came, it was possible that the arch might stand, while the walls, built of poorer material, were destroyed. There was one peculiarity about the photographs, in that what Dr. Cornish called the partition walls often stood and supported the roof, while the outer walls fell down. He would like to ask whether these were partition walls as we understood the words. An English house is generally built with the partitions weaker than the outer walls, but the

photographs suggested that in Kingston the former often constituted the essential framework of the building, and that the outer walls were additions built of inferior material. If that were the case, it would be easy to understand how they might be thrown down, while the central framework remained standing.

Dr. LONGSTAFF: It was my good or bad fortune to be, like the lecturer, an unwilling spectator of the earthquake in Jamaica. I was thinking of going into the Conference Hall, merely waiting for the speaker to sit down, when I heard a noise and felt a shaking, and said, "Hallo, I am in for the earthquake which I have always wished to experience." There was a noise, as though the tiles were coming down, but I did not see any tiles come down. I thought I would go out, because if there were a panic, I should be thrown down. I went to the top of the staircase, and went about halfway down, when I thought I was pushed from behind. I finished the descent head first on my back, and found myself standing on my head in the middle of the street, but picked myself up not materially the worse, and thought what a very trivial earthquake that was to be in. To prove how little it affected the people, I may say they came out of the building two by two, and a gentleman came up to speak to me. I said, "Hallo, you have been down, as I have been; if you will dust my coat, I will dust yours." I had some difficulty in coming down to the place where I found my wife. She was going up a staircase close to a big window, and was struck with the astonishing brilliance of the day. At that moment she felt the sensation of a very heavy vertical blow from underneath upon the stairs. She grasped the situation at once, and turned round to go out. The whole place was shrouded in darkness from the quantity of dust; the wall to her right hand was waving backwards and forwards, and bricks were falling from the top of it. She went through a volley of bricks, almost feeling her way, and down two or three steps into the street. I visited the building a few days afterwards; the whole of the upper story of that building had fallen outwards; my wife had apparently gone through three or four cart-loads of bricks. Now, after this personal experience I cannot but recount the experience of a man, Mr. Abel, whom I met afterwards. He was at the Constant Spring Hotel, watching a lawn-tennis match. He had had a sunstroke in India some years before. He said that the lawn appeared to be blown up and down in waves, and he said, "Gracious me! I have got the sunstroke again!" Then he raised his eyes to one of the stonework tiers of the hotel; he saw an immense crack that extended from the bottom of the building to the top, and it was sufficiently wide at the top that a man on horseback could have ridden through it. The lecturer has made no allusion to the remarkable fracture of the cable about 11 miles south-east of Port Royal. Now, that is a very extraordinary thing which has to be accounted for somehow or other. Then there is another thing which must be borne in mind, and it is especially interesting of this earthquake, for, as far as I can see, the maximum intensity was somewhere between or near the south-eastern corner of Kingston, or somewhere thereabouts. Well, that is extremely near Port Royal, or where the maximum disturbance occurred in the earthquake two hundred years previously. I think that fact is interesting when considered in connection with the question of faults. Two or three days before the earthquake I was walking through the streets of Kingston, and I said, "Good gracious! how they do need a Building Act here! What a shockingly built city it is! how bad the material!" and I think the account of the enormous amount of dust raised by the earthquake is almost a proof of the badness of the mortar. Now, with reference to arches, I notice that semicircle arches stood the earthquake very well, but Gothic arches stood it badly. I am sorry Dr. Cornish did not get to Spanish Town. It is very interesting, as containing buildings of all sorts of descriptions of strength, and being a considerable distance off, and where the

damage done was considerable, but yet very little was thrown down. We are, therefore, better able to see the lines of force and what happened; and one curious thing there is, that the maximum line was north and south, yet one thing that was noticed very much there is that the north and south walls had gone at the junction to the lateral walls. The lateral walls had stood, and the north walls that had been thrown down had been broken off at the ends. The tensile strength of the stonework used in Jamaica is very poor—indeed, almost poorer than brickwork. It is a soft calcareous limestone, practically coral rock, which is very often built in irregular shapes, and the lines of fracture of the earthquake will go from top to bottom through the stone. Brickwork appears to be better than stonework, and, of course, wood is better than either. A brick building is both heavy and has slight tensile strength, whereas a wood building is light and has considerable tensile strength; and therefore it seems to me that you want to combine as little weight as possible with the maximum of tensile spring. A further question arises, which the lecturer did not allude to, and that is, what should any of us do in the event of finding ourselves in a building when an earthquake took place? I have great confidence in saying, if you are in bed, stop in bed, unless you feel inclined to get under the bed. You can practically do nothing—you must wait till it is over; but the danger in some cases is greater than in others, and the danger is greatest of all just outside your own front door. It is better to stop inside a building—you may be killed, and you may not.

The PRESIDENT: I do not fear, with Dr. Strahan, that we may perhaps have been going beyond our province, for geography deals with the surface of the globe and with ourselves who live upon it. Earthquakes will insist upon coming to the surface—that is the worst of them—so that we must deal with them geographically. I am impressed with a melancholy coincidence. We all remember the story of the lady who said how providential it was that most great cities had rivers flowing near them. It struck me, while looking at Dr. Cornish's valuable map, that it was the reverse of providential that Jamaica's chief city happened to be close to the centre of the area of disturbance, thus resulting in a deplorable loss of life. We tender to Dr. Cornish our most cordial thanks.

Dr. CORNISH: At this late hour I will not detain you with any lengthy reply to the various interesting remarks that have been made by different speakers. I compressed my account as much as possible in order to allow ample time for those who were to follow, and many of the points which are raised are, in fact, answered to the best of my ability in the written paper, to which I will venture to refer you.

The following discussion took place at the meeting of the Research Department:—

Mr. R. D. OLDHAM complimented Dr. Cornish on the acumen of his observations and the importance and interest of the observations which he had gathered together in his first attempt at seismological research, but was unable to agree with Dr. Cornish in some of his deductions. As regards the "double-barrelled" origin of the earthquake, the concept seemed to him out of date; the old mathematical hypothesis of an origin so limited in size that it might be regarded as a point had long been abandoned, and the origin of great earthquakes recognized as a more or less extended fissure, to use the nearest word available. A very striking paper on earthquake origins, by Colonel Harboe, has showed that these fissures very probably ramify over a much more extensive area than used to be supposed, and are probably coextensive with the area of sensible shock. In view of this explanation, the supposition of more than one focus becomes modified into that of a single extended origin with a varying intensity of disturbance in different portions. The discussion as to whether the motion of the wave-particle was in the direction of the wave path, or transverse to it, seemed superfluous in

the face of our knowledge that it could be neither. The direction of overthrow of pillars was no longer accepted as an indication of wave-motion; it approximately coincided on the average with that of the direction of maximum amplitude and acceleration, but arguments derived from data of this character had to be used with great caution, and were especially uncertain when derived from isolated cases of overthrow.

Dr. CORNISH: Mr. Oldham says that experienced seismologists have long abandoned the theory that the origin of an earthquake is a point. He says that, for convenience, they call it a fissure, and that it has considerable extension. I have not described the foci of the Jamaica earthquake as points, but as long lines not necessarily straight, which is precisely the form which Mr. Oldham says is favoured by experienced seismologists, and I have avoided the use of the term "fissure," of which he does not wholly approve.

But Mr. Oldham then suggested that earthquakes do not, in fact, come from any such definite origin, but that there is a large area over which the intensity is great, shading off, as I understand him, gradually into the surrounding area without anything to indicate an origin possessing even the shape of a fissure. I must traverse his implication that this is a view at all universal among experienced seismologists, or that an assumption to the contrary is antiquated. Prof. J. Milne, for instance, at the meeting of Section E of the British Association in August, 1907, attributed the principal part of the Jamaica earthquake to a fault, which he spoke of as "the main fault," and for which he specified a definite direction. Dr. Charles Davison, in his well-known papers upon recent earthquakes, frequently traces their origin to a definite line of faulting. Right or wrong, therefore, the treatment is neither antiquated nor contrary to the methods of experienced workers. Moreover, in the case of the great Californian earthquake of 1906, commonly called the San Francisco earthquake, it is matter of common knowledge that the effects grouped themselves about a long line of fracture plainly visible on the surface, and the investigators have further stated that this is the line of a previously known geological fault.

With regard to the connection between the direction of after-shocks and that of the main shocks, it will be seen, on reference to my paper, that I have made no assumption of inevitable coincidence; but when Mr. Oldham says that, although due to the same original cause, it is illogical to suppose them to come from the same place, I think he overstates his case, and in support of this opinion I will draw attention again to that set of after-shocks which was most strongly felt at Kingston. Their average direction was from about 15° south of east, which is the direction in which buildings in Kingston fell, and the direction from which many facts indicate that the chief original shock came. Now, if the original cause be the same, and if, as in this case, the direction of approach be the same for original shock and after-shock, surely the logical burden lies on him who asserts that their places of origin are different.

I am glad that Mr. Oldham considers that the facts I have gathered form a useful basis for theoretical treatment; but I confess I am disappointed that he has given so little indication of the manner in which he would propose to deal with them. I think that, if you recall the history of scientific research, you will agree that a theory which groups together facts and explains them will hold the field, until another theory is put forward which explains more facts and explains them better. I think, therefore, that my treatment of the Jamaica earthquake will have to last, possibly to the detriment of science, until a better and more definite theory is advanced, which perhaps Mr. Oldham may achieve, but which he has not yet done.

Major CLOSE: I am sure you will wish me to thank Dr. Vaughan Cornish for his very excellent and instructive paper. The facts he has brought forward will prove most valuable to all those interested in the subject.

IN SEARCH OF AN ARCTIC CONTINENT.*

By A. H. HARRISON.

In starting on this expedition into the Arctic ocean, I hoped to achieve results which, however incomplete, might be of some slight service in adding to the knowledge already possessed of the North Polar Regions.

On July 4, 1905, I arrived at Edmonton, which is the most northerly post of the Canadian Pacific railway. After a few days' delay I went on to Athabasca Landing, where I had a skow—that is to say, a flat-bottomed boat—built. We started down the river on the 22nd with two years' provisions, some of which I had bought here and some at Edmonton. From Athabasca Landing to the Grand rapids—a distance of 165 miles—there is a very fine country, which is little known, and doubtless will one day be as thickly populated as any part of Canada. The rapids, which extend for the distance of 87 miles, are somewhat awkward to navigate; but, with the exception of the Grand rapid, no other part of the river offers any difficulty.

After leaving the rapids, a distance of 185 miles is travelled to Fort Chipewyan, after which the Slave river is reached; it wends its course for 312 miles into Great Slave lake. The navigation of the Slave river is very simple, with the exception of 15 miles of rapids, which have to be portaged over at Fort Smith. From Fort Resolution across Slave lake, Hay river is the first harbour, a distance of 70 miles. From Hay river to Fort Providence, which is the first post on the Mackenzie river, the only difficulty is getting into the river, the channel of which is crooked, and in many places shallow. From Fort Providence down to the Arctic Red river, lat. 67° 26′, long. 134° 4′, where I got frozen in, the distance is 900 miles, and the navigation is exceedingly simple for the whole distance.

The country that one passes through from Athabasca Landing down to the Arctic Red river is full of vegetation, and will, in my opinion, one day be settled. In all the mission gardens at the different posts that I passed, I saw wheat and barley growing, potatoes, lettuces, turnips, carrots, and every kind of vegetable that one grows in one's own garden at home. The country is thickly timbered near the banks of the river, and there are few places in which you do not find large patches of prairie. You pass by a great outrush of natural gas, and oil is oozing out for miles along the river bank. An Earth-movement has taken place, resulting in a line of fault, which is marked for more than 100 miles along the bank of the Athabasca river. Out of this, oil has been oozing we do not know for how long, and no one has yet found

* Map, p. 360. Read at the Royal Geographical Society, December 16, 1907.

the reservoir of oil which may exist there. A German noble, the Count von Hammerstein, has spent a great deal of his own money and time in trying to find the reservoir, and I most sincerely hope that he may be successful. Coal and asphalt are to be seen everywhere, and there are great salt-plains not far distant. If three railways were run on to this great waterway (which could be done with a small outlay in comparison with the value of the country they would open up to the settler), the benefits reaped would be great. I should be an advocate for railways being built to Athabasca Landing from Edmonton, which would give easy access to 165 miles of river in one direction, and 210 miles in another up to Lesser Slave lake. A railway on to the Peace river would open up the whole of that waterway a distance of 600 miles down to the Slave river; while one railway from Prince Albert's to Fort McMurray would open up the Athabasca and the Slave rivers. The navigation on these waterways is effected with ease; any one can build a raft out of the timber which is at hand, place his cattle and farm implements upon it, and drift down the river until he finds the land he requires.

After traversing some 1800 miles of waterway, and taking observations for latitude and variation of compass at every point, I was frozen in at the Arctic Red river on October 4, and my position was that I had either to abandon all my supplies, or remain where I was until open water in 1906, which would mean wasting one year. I at once made up my mind to abandon the supplies and to go on with the dogs to Herschel island, a distance of 240 miles. This was not quite such an easy task as it appeared. After a great deal of difficulty and many journeys over to Fort McPherson, I at last succeeded in persuading two natives to accompany me to Herschel island with two sledges. One of the greatest difficulties that the traveller has in these parts is the economizing of supplies. Taking nothing with me but a Primus cooking-stove, instruments, and food, I could not reduce the weight of the sledges to less than 400 lbs. One sledge had 401 lbs. on it, and the other 405 lbs. There was a team of six dogs to each sledge.

We left Fort McPherson, on the Peel river, on February 14, and after travelling for ten days at an average of 24 miles a day, we got to Herschel island. Here I was in hopes of getting some supplies from the whalers, and making a sledge journey out on the ice, but, unfortunately, I found that they were all bound for San Francisco, and had been frozen in about a month earlier than usual, without any supplies for the present winter. I had abandoned my own supplies for no other reason than to make a trip out on the ice, and when I found it impossible to get anything at Herschel island either for myself or my dogs, I had to abandon the idea of going out on the ice. From what I gathered from the captains, I concluded that they had been out as far from land as any one could get with a properly equipped sledge expedition, on account of

open water, which I think exists off that coast, and I am still of the same opinion.

The position at Herschel island was briefly this: There were two hundred and fifty people on board five ice-bound ships, and of these only two vessels had any supplies at all. They divided up these stores, and, by keeping every one upon half-rations, there was only just enough food to last them until the middle of July. At the time of my arrival—February 24—the Eskimo were killing cariboo in the mountains within a few days' distance of Herschel island, where the deer-meat was most valuable to every one, but to bring it down from the mountains was a matter of great difficulty owing to the scarcity of dogs. Accordingly, I resolved to go into the mountains myself, and to lend my dogs to the whalers to get their deer-meat. I wanted to meet the Eskimo and to learn something about their language, in order that I might make use of them next year.

At the end of April I returned again to the ships, and made a map of Herschel island, which I did by triangulation, measuring my base out on the ice, and extending it over the island. This occupied me until we sailed.

On the 29th, while in the mountains, I saw the first fly—a blue-bottle. On May 31 we got our first geese, and on June 4 the first fish were caught at Herschel island. During this time I carefully noted all such days as were marked by the flight of wildfowl; and for two days early in June saw swan flying north-east true, great numbers of them passing Herschel island at a great height, and all going in the same direction. These were the only birds I saw not flying along the coast.

On June 16 I left the ships again to go over to the south-west sandspit, taking with me an Eskimo called Kokatu and his family. In crossing the bay, we passed over several lanes, which were about 12 feet wide in the narrowest place. On Monday, June 18, there was no sign of open water anywhere, and on Wednesday the 20th it was all open water. On July 1 the ice was full of holes, which rendered travelling quite impossible. I went back to the ships on July 3, going over the island, and on July 10 we put to sea. There was nothing but floe-ice in sight, with several lanes, and, after a great many difficulties and delays, we got to Point Sabine, and there took on driftwood to burn, as the ships had but little coal. We loaded every available space with wood, which, mixed with a little coal, lasted till August 14.

On July 12 we left Point Sabine and steamed round Pullen island, being in the ice most of the time. Whenever we could not go forward, we tied up to a piece of ice. There were plenty of seals and wildfowl in the water; and off the north side of Pullen island we encountered a great deal of old ice, which was drifting to the west. One of the ships tried to anchor, and lost its anchor; another ship injured its propeller. After leaving Pullen island we did not encounter much ice, but steamed

about 10 miles off shore to Cape Brown, afterwards crossing Liverpool bay to the Baillie islands off Cape Bathurst. While here I made a map of these islands, and got observations for latitude, longitude, and variation of the compass. Here we had a few days' delay, on account of a great mass of old ice which lay to the north-east of this point. I went out on this ice from the north end of Baillie island; it was quite stationary, and there were many pieces that I thought were 20 feet high.

On July 27 we tried to get round the Baillie islands. We steamed all day in a north-westerly direction, in heavy old ice all the time, and at six o'clock we tied up to a piece of ice. We were 20 miles off shore, and in 14 fathoms of water, and the ice was drifting to the west. As we were unable to make any headway, and as more ice was coming down from the north, we were driven back to the Baillie islands, where we had to take refuge on the east side of the sandspit.

We started again on August 3, and, after struggling with the old ice most of the day, steamed out into open water, and went straight across to Nelson's head, Banks Land. We got within a mile of Nelson's head, and steamed up the west shore of Banks Land, without seeing a piece of ice anywhere, as far as Cape Kellett. This was on August 5 and 6. On Cape Kellett there were a few pieces of old ice aground, and though I could see with my glasses the pebbles and stones on the beach, I could not descry a vestige of driftwood anywhere on this west shore. It was blowing hard on the 5th and 6th, so we did not anchor. I could not say whether there was a current along this shore or not, but, seeing no driftwood, I concluded that there must be a current from the north or south. If there *were* such a current from the north, and an ice-bound ocean to the north, it must needs bring down ice along the Canadian shore throughout the year; but during the time of open water that I spent on that coast, it was seldom that I saw any drift-ice. After we got away from the ice on August 4, there was really none to speak of within 50 miles north of the Canadian coast; this date agrees well with the date of open water round Point Barrow and Cape Kellett. There seem to be three points where the ice accumulates, and they are all clear about the first week in August. There was one year when the whale ships were unable to get to Banks Land, and this year north-west winds prevailed, and ice of this description extended everywhere from Cape Bathurst to Banks Land 10 miles off shore. A north-east wind prevailed whilst I was cruising in these waters, and on returning to Herschel island, I heard that they had had nothing but north-west winds.

On July 29 Captain Cottle was 50 miles north true of Herschel island. Current was running north-west true, and there were large floes in sight; and it was reported to me that in September Captain Levett was 100 miles north of Herschel island, and killed a whale, with no ice in sight. After leaving Cape Kellett we steamed out north-west

true, seeing no ice, and came round eventually, after about three days, to Liverpool bay. There was a little ice still off the Baillie islands, about the same amount as there was off Cape Kellett. Between here and Herschel island, we steamed out some 50 miles from shore, and only saw a few floes of old ice, which was at that time drifting west. We had had continual north-easterly winds.

On August 14, 1906, we got back to Herschel island. Here we had expected to find a tender bringing up coal and supplies for the ships to go out with, and I had arranged to get two years' supplies, which would have enabled me to complete the work which I came out to do; but, unfortunately, we received instead the news of the destruction of San Francisco by fires and earthquakes. To the whale-fishers, who all had their homes in San Francisco, and who had just gone through a winter of exceptional hardship, the blow was a hard one, and, after waiting for a week, they gave up all hopes of the tender, and started west on August 21. They offered to take me to San Francisco, nor have I ever received greater consideration from any one than was shown me by these brave fellows during my stay with them. I might also add that, though they have taken a great wealth of whalebone out of these waters, they earn every pound they make. As soon as I went ashore at Herschel island, I engaged two Eskimo and their families for one year to hunt for me and clothe me and keep me. They had a whale-boat each, and I had bought one from the whale-fishers.

On August 29 we left Herschel island; I intended to winter wherever game could be found, and wait in the Arctic for another year or two, if necessary. With this intention, I arranged with a whaling captain to bring me up two years' supplies. I went up the west branch of the Mackenzie river to Fort McPherson with three whale-boats, making a route survey of the river and taking observations for latitude, longitude, and variation of compass whenever possible; here I got some ammunition and rifles which I had left there the year before. I also obtained some supplies from Messrs. Nagle and Hislop, and started down the east branch of the Mackenzie for the Eskimo lakes, where I intended to winter. We got frozen in at the north-east end of what I call the Long lake, and here we left our whale-boats. We were now a party of thirteen, with eighteen dogs. We were in hopes of finding both deer and fish, but we found very few of either until late in November. We had to struggle for existence until October 20, when I decided to push on to the east. We travelled over a height of land, through a valley, for a distance of 27 miles, and came to the first Eskimo lake. After crossing the lake, we found, at the north-west end of it, a little river where there was open water and abundance of fish. We took as many as seventy white fish out of our net every time we went to it. The natives also caught from fifteen to twenty trout every day, and by setting night lines some losche were caught every

night. Finding no deer in the country, I thought this was too good a thing to pass, and so I decided to winter here. I had surveyed the country as far as this, getting observations for latitude, longitude, and variation of compass everywhere along the route, but now I hoped to get a few occultations. We were now near the edge of the timber-line, but there was plenty of wood to build a house and to make fires, so I told the natives to build two houses—one for myself, and one for them. I stayed here until January 19, when I went down to the coast, returning by another route, and reaching camp the second week in February. During this journey we had four cold spells, the thermometer once registering from 50° to 57° below zero for a week. I surveyed the route I took and the route I returned by; the country between my winter camp and the coast is a mass of small lakes and hills, which are often conspicuous for the volcanic appearance they have, but they are not of volcanic origin.

The Eskimo told me we should get no fish after the sun had returned. Even when I left camp fish were not numerous, but when I came back they could not be caught by hook or by crook, nets and hooks being both useless. My scanty supplies having all gone, we had a very hard struggle for existence, and for six weeks we lived on ptarmigan, which the natives snared with twine or shot on the neighbouring hills, and on musk-rats, which were caught on the lakes under the snow in small traps. Needless to say, our fare was a very scanty one, but we managed to keep most of our dogs and ourselves alive until March 25, when we started off in an easterly direction down the great waterway (which I particularly wanted to survey) into Liverpool bay. I took with me two natives, the women and children, and the dogs, which now numbered only twelve, as I had lost some during these hard times from starvation.

I followed and surveyed this great waterway by stations of triangulation, route surveys with a prismatic compass, and observations for latitude, longitude, and variation of compass whenever possible until I got in sight of Liverpool bay, and here, through shortness of food, we had to go to the coast. The country between the Eskimo lakes and the coast is particularly flat, dotted with conspicuous hills rising straight up out of the ground. According to Sir J. Richardson, they are of gravel and mud formation, but the abrupt angle they form with the plain is particularly interesting if this is correct. After five days of starvation, which forced us to kill two dogs to keep the rest alive, we arrived at Kangianik, where an old Eskimo called Tiukpuna treated us with great hospitality. I surveyed this coast-line carefully with a prismatic compass, getting observations whenever possible, and found the sandspits and points to be of a curious length and shape; this is a feature of the whole coast-line. During this time I never heard the natives complain, and they always appeared as cheerful as if they had

plenty to eat. On May 3 we went to the east branch of the Mackenzie river, travelling up it knee-deep through soft snow and slush; nor were we able to put our sledge ashore, by reason of the open water on either side of the river, but had to camp every night on the middle of the ice. However, we managed to get to our whale-boats before the ice on the river broke up, when we again suffered considerable privations on account of the scarcity of food. On May 14 we got our first wildfowl, and after this we enjoyed plenty, such as it was, until I returned to Fort McPherson in June, where I waited for my mail which brought me home. Coming down the Mackenzie river, when in sight of Point Separation, the high ground on the east side does not follow the present course of the river, though the bank is 40 feet high, and thickly timbered; but the hills are some way to the east, and run in a straight line to the south end of the Long lake, and from here they can be traced to Liverpool bay, on the south-east side of the Eskimo lakes.

Where this little river, which we went up in our whale-boats to get to the Long lake, enters the Mackenzie river there is high ground, which you can also follow to Liverpool bay in one direction, and to Richard island in another. From here to Richard island the Mackenzie flows close under the height of land, and in some places the banks are precipitous. The country between the Eskimo lakes and the coast slopes down more gradually from the Mackenzie river into a very flat coast-line, extending 10 miles from the ocean, and is dotted all over with conspicuous hills. They rise out of the flat ground from 100 to 200 feet, and the top forms a round basin 5 to 10 feet deep in the centre. The natives value those near the coast as certain reservoirs of water. In the mountains on the west side of the Mackenzie to the south and east the slopes appear precipitous, and to the north and west more gradual.

The Mackenzie river begins to widen out into a delta at Point Separation, which is 200 miles by water from the most northerly island, and in its widest place is 45 miles broad. The west branch of the river breaks up into many channels, which have cut their way through a plain lying immediately under the mountains. West of this plain you come to Shingle point, and this forms a bay with the sand-bars, which extend in a westerly direction from Tent island.

The main channel of this river wends its way through many islands along the coast between Hooper and Pullen islands. The east branch comes into the ocean by many channels, lying between the north-east corner of Richard island and Toker point; that between the mainland and Richard island is narrow up to Point Encounter. From here it widens, but there are many sandbars in the bay formed by the north-east end of Richard island and Toker point. From the north-east end of Herschel island there is a bank which extends in an easterly direction, and is called the "ridge:" it is over this ridge that there is always a large tidal crack in the ice every year.

Much of the driftwood that comes out of the Mackenzie is caught by these islands and sandbars, but some of it is carried out to sea. For example, after leaving Point Sabine I saw driftwood, on July 12, floating in the ocean 9 miles off shore; off Pullen island, 10 miles to the north, I saw more of it; on July 16 and on July 18, off Toker point, some 10 miles from shore, we passed a quantity of driftwood. The shores of the Arctic ocean from Cape Parry to Herschel island are strewn with this strong timber, which comes down the Mackenzie, the Clarence, the Anderson, and the Horton rivers; there are only two places between these points where wood is not found, and the reason is that the shores are precipitous. These rivers are building up islands on what were submerged banks, and the ocean is receding. In all these islands I found ancient driftwood in the high banks. While making a map of Herschel island, I found in many of the gullies pieces of similar wood, sticking out of the mud in the bank, in most cases 50 feet below the present surface of the islands. The whaling captains who blasted out the ice-houses at Herschel island told me they found quantities of this same wood. The ice-houses are 20 feet below the surface, and go down to sea-level. The wood I saw off Sabine point was drifting to the west, and that off Pullen island and Toker point to the east. What wood I saw is a very small portion of that which is carried out to sea, and it is difficult to understand why a great deal of this *débris* is not drifting on to the western shores of Banks Land. The absence of driftwood upon the western shore of Banks Land would seem to indicate a current that is perhaps being diverted on to that land by other land to the north and west.

In the preceding pages I have told the story of my journey. Although circumstances prevented me from actually going out on to the ice to investigate the Arctic mysteries, I saw enough during my stay of eighteen months on the shores of the Arctic ocean to somewhat justify the conclusion that our data at present are quite insufficient to establish the existence of a vast polar sea. It is true that most competent authorities hold that no extensive land can be found in the unknown region; with this conclusion we may agree from want of further knowledge, but when we came to examine the reasons they advance, to say the least of it, they are not convincing. The real conclusion to be drawn from what is known seems to be that the existence or non-existence of land is as much an open question as ever. Apart from the fact that authorities of the greatest weight draw diametrically opposite conclusions from the same data, does it not seem somewhat premature to describe the geographical condition of an unexplored region from a mere study of its boundaries? Let us take an example. Suppose we did not know of the existence of Australia, who, I ask, from a study of the geographical conditions which obtain between the 5th and 10th degrees of S. lat., could ever have deduced the existence of a great

continent like Australia? Is it not, from first principles, both dangerous and scarcely in accordance with strict scientific methods of reasoning to deduce the existence of any physical fact which has never been put to the test of experience?

I have at the present moment before me a map by Dr. Nansen, showing a deep basin in the unknown area; a map by R. A. Harris, showing a continental mass of land; a map by Commander Peary, showing a land to the north-west of Grant Land, which he has never visited, but has named "Crocker Land." The whole inference is from known facts. How can we be at all sure that we know all the facts?

The Soundings found by the "Fram."—If we consider the known facts, the soundings found by the *Fram* might be taken to denote land at the pole. For example, from where the *Fram* got frozen in to where she got free roughly represents 1000 miles. We know something of what exists south of this line; to the north we know nothing. Now, let us measure 1000 miles in the same drift, along the meridian, from 80° to 63° N. lat. Throughout this distance we know that land exists on both sides of us, east and west, that the deep channel is narrow, and that the soundings are even deeper in places than any found by the *Fram*.

Let us suppose we did not know of the existence of Greenland, and let us suppose some one were to go out on the ice in a westerly direction from the Spitsbergen archipelago, and came back with the soundings of 2600 fathoms, found 175 miles west of Spitsbergen. Could we infer that if he had continued his course for another 200 miles he would have found Greenland?

The Drift of the Ocean.—Nothing that has been put down or got drift east of Point Barrow has ever been heard of again. Many ships have been wrecked. For example, four vessels were wrecked east of Point Barrow while I was on that coast; nine drift casks were set adrift east of Point Barrow in 1899 and 1900; again, whale ships have been passing every year east of Herschel island since 1889, and there was no part of the Arctic coast that I visited where I did not find among the driftwood derelict belongings bearing the name of these ships. In the case of wrecked vessels, they may have been smashed by the ice and sunk, but there are many things on a ship which cannot sink, and which have the ship's name upon them. Now, I ask, how does it happen that none of the immense quantity of *débris* which, in accordance with the above facts, has been set adrift, has never yet found its way, as far as our present knowledge goes, across the Arctic ocean?

We know that a drift cask did drift from Bering strait to Iceland. In considering the known drift of the ocean, we cannot take the drift of the *Jeannette* and the *Fram* jointly, but the drift of the *Jeannette* and her relics give us fairly safe data from which to estimate the course taken by the buoy.

We may take it for granted, from what we know of the drift of the

Jeannette and her relics, that the speed of the buoy can hardly have been less than 2 miles per day of twenty-four hours. This rate receives further confirmation from the able arguments of Dr. Nansen, respecting the drift of these same relics.* But if the buoy took the shortest possible route across the pole, it scarcely attained a speed of 1·2 miles per day of twenty-four hours. Therefore we may assume that the buoy did not go by the shortest route. But we may go further, it must have gone a longer route than the known route of the *Jeannette* and the *Fram*, for the latter would only give us an average rate of 1·5 mile per day. Therefore, may we not conclude, on the 2 miles a day hypothesis, that the buoy travelled by a longer route even than the *Jeannette* and the *Fram*?

The Ice.—If we assume that this buoy drifted across the Arctic ocean north of the *Fram's* route, as Dr. Nansen suggests,† it is difficult to suppose an extensive land or any mass of palæocrystic ice in the unknown area. This I estimate, taking out all known ice journeys, to be 1,251,874 square miles in extent, and the Arctic ocean has an estimated area of between 4 and 5 million square miles.‡ Now, what is the significance of the six years' drift of this buoy? Does it mean that the polar sea clears itself of ice every six years? If this is the case, what becomes of all this ice? Assuming that the total breadth of the channels leading out of this enclosed sea is 1000 miles, and that the average rate of the current flowing through them is 2 miles a day of twenty-four hours, it would take ten years at least for the 4 million square miles of ice to pass through, even on the assumption that the flow continued for two hundred days every year.

Some slight corroboration of the above argument may be found in Commander Peary's experiences.§ The drift shown by these ice journeys north of Greenland and Grant Land running west to east, does not indicate a current passing over or near the pole and coming from Behring strait, but rather a current running in exactly the opposite direction to the current in which the *Fram* drifted.

In conclusion, I may repeat what I said at the beginning, that the existence of land at the pole is by no means yet disproved. Without attaching too much weight to the arguments I have advanced, they do at least suggest some difficulties in the way of the deep-sea basin theory. There is yet some room for searchers of Arctic continents, and nothing would please me better than to have the means and opportunity of once more trying to solve this great Arctic mystery.

* Dr. Nansen's 'Furthest North,' vol. 1, p. 20.

† *Geographical Journal*, December, 1907, "North Polar Problems."

‡ The *Bulletin* of the Geographical Society of Philadelphia, January, 1906, vol. 4 p. 3.

§ Commander Peary's map, 'Nearest the Pole.'

ORDNANCE SURVEY MAPS.

For large-scale maps, Mr. E. Stanford, 12, 13 and 14, Long Acre, W.C., is the London agent; there are also provincial agents in most of the important towns of England, Scotland, and Ireland. Publications may also be ordered through any bookseller. For all small-scale maps, Mr. T. Fisher Unwin, 1, Adelphi Terrace, London, W.C., is the wholesale agent, and he supplies the various retail agents and bookstalls, from which they can be obtained.

The following is a list of the various Ordnance Survey Maps of the British Isles on sale to the public, together with the prices:—

	Price per sheet. On paper. s. d.	Mtd. on linen. s. d.
$\frac{1}{1000000}$ or 15·782 miles to 1-inch Scale.		
1. United Kingdom. In two sheets, unmounted. Size 34½ × 24½ inches. Price 5s.		
Mounted as a wall map, 10s.		
Ditto, with moulding and roller, 16s.		
10 miles to 1-inch Scale.		
2. Great Britain, engraved. Printed from a transfer from copper, latitude and longitude not marked.		
(a) Outline edition in 12 sheets, water in blue. Size about 20 × 13 inches. On paper	1 0	
(b) Hill shaded edition in 8 sheets, with hills in brown, roads sienna and water blue. (Sheets (1 and 2) (3 and 4) (5 and 6) (7 and 8) of this edition are combined.) On paper	1 0	
Ditto, on thin paper, folded in cover or unfolded	1 0	1 6
Sheets specially printed for mounting as one map, together with a title sheet and marginal lines. Price 9s. per set.		
The above sheets, mounted on holland, to form one map, and bound with blue ribbon. Price complete, £1 1s.; or with moulding and roller, £1 10s.		
3. Ireland, engraved. Latitude and longitude marked.		
(a) Outline edition. Size about 36 × 27½ inches. On paper	2 6	
(b) Hill shaded edition, printed from a transfer from copper, with hills in brown, roads sienna, and water blue. On paper	2 6	
Ditto. Mounted on holland, and bound with ribbon. Price 5s.; or with moulding and roller, 10s.		
4 miles to 1-inch Scale.		
4. England and Wales, engraved in black, latitude and longitude marked, no hill shading or contours. Size 22½ × 15 inches. On paper	1 6	
5. England and Wales, engraved. Printed from a transfer from copper, hills in brown, roads sienna, water blue, woods green. Size 22½ × 15 inches.		
(a) On paper	1 6	
(b) On thin paper, folded in cover or unfolded	1 6	2 0
6. Scotland, engraved. Printed from a transfer from copper, with water in blue, latitude and longitude marked, no hill shading or contours. Size 18 × 12 inches. On paper	1 0	
7. Scotland, engraved. Printed from a transfer from copper, hills in brown, roads sienna, water blue, woods green. Size 18 × 12 inches.		
(a) On paper	1 0	
(b) On thin paper, folded in cover or unfolded	1 0	1 6
8. Ireland, engraved. Printed from a transfer from copper, with water in blue. Size 18 × 12 inches. On paper	1 0	
9. Ireland, engraved. Printed from a transfer from copper, hills in brown, roads sienna, water blue, woods green. Size 18 × 12 inches		
(a) On paper	1 0	
(b) On thin paper, folded in cover or unfolded	1 0	1 6
10. County and District Maps of Great Britain, cheap edition, roads in brown, latitude and longitude marked, on thin paper or folded in cover. In sheets. Unmounted 6d. to	1 0	
Folded in cover 9d. and	1 0	
2 miles to 1-inch Scale.		
11. England and Wales, photo-etched on copper. Printed from a transfer from copper, hills and contours in brown, principal roads burnt sienna, woods green, water blue, latitude and longitude marked. Size 18 × 12 inches.		
(a) Folded in cover or unfolded	1 0	1 6
(b) Combined sheets (various sizes) folded in cover or unfolded	1 6	2 0
*New series in large sheets. Size 27 × 18 inches. Folded in cover or unfolded	1 6	2 0
12.*Scotland, photo etched on copper. Printed from a transfer from copper, hills and contours in brown, principal roads burnt sienna, woods green, water blue, latitude and longitude marked. Size 24 × 18 inches	1 6	2 0

* Publication in progress.

	On paper. s. d.
1-inch Scale.	
13. England and Wales, outline, contours in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0
14. England and Wales, hills hachured in brown, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0
15. Ditto, hills hachured in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0
16. Ditto, hills hachured in brown, contours red, roads sienna, water blue, woods green (on revised edition), magnetic variation shown, latitude and longitude not marked. Size 18 × 12 inches. On thin paper, either flat or folded in cover. Single sheets	1 0
Combined sheets	1 6
* New Series in large sheets. Size 27 × 18 inches. Flat or folded in cover	1 6
17. Scotland, outline and contours in black, latitude and longitude marked. Size 24 × 18 inches. On paper	1 6
18.*Ditto, hills hachured in brown or black, with black contours, latitude and longitude marked. Size 24 × 18 inches. On paper	1 6
19.*Ditto, hills hachured in brown, contours red, roads sienna, water blue, woods green, magnetic variation shown, latitude and longitude not marked. Size 24 × 18 inches. On thin paper, either flat or folded in covers	1 6
20. Ireland, outline, not contoured, in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0
21. Ditto, outline, not contoured, in black, latitude and longitude marked, showing county, rural, urban, and county borough boundaries in red. Size 18 × 12 inches	1 0
22. Ditto, hills hachured in black, latitude and longitude marked. Si 18 × 12 inches. On paper	1 0
23. Ditto, hills hachured in brown, roads sienna, water blue, woods green, latitude and longitude not marked. Size 18 × 12 inches. On thin paper, either flat or folded in cover	1 0
Combined sheets	1 6
24. Combined maps of areas round certain large towns, or other areas, such as the New Forest and Lake District, and published in various forms and sizes. These maps usually show outline and contour in black and roads in brown. In sheets, unmounted or folded . . 1*s.* to	1 6
In cover 1*s.* 6*d.* to	2 0
6-Inch Scale.	
25. Great Britain, water coloured blue or back lined, contours in black, latitude and longitude marked. Heliozincographed or photozincographed. Size 18 × 12 inches . .	1 0
Engraved or photozincographed (where not published in quarter sheets). Size 36 × 24 inches	2 6
26. Ireland, engraved or heliozincographed, contours in black, latitude and longitude not marked. Size 36 × 24 inches	2 6
$\frac{1}{2500}$ Scale.	
27. Houses ruled or stippled in black, water blue or back lined, latitude and longitude not marked. Size 38 × 25½ inches	3 0
28. Houses red, water blue, roads brown, latitude and longitude not marked. Unrevised editions only coloured in this form. Size 38 × 25½ inches. From 2*s.* 6*d.* to 23*s.*, according to the amount of colouring. This form is gradually being superseded by 26.	
Town Scales.	
29. $\frac{1}{500}$ scale, houses ruled or stippled. Size 38 × 25½	2 6
30. Ditto, houses red, water blue, roads brown. Size 38 × 25½ inches. From 2*s.* 6*d.* to 15*s.*, according to the amount of colouring. Applies to unrevised only.	
31. 5-feet scale, houses stippled. Revised. Size 36 × 24 inches	2 6
Index Maps.	
32. Indexes to the sheets of the 1-inch scale maps of England and Wales, Scotland, and Ireland, scale 30 and 27 miles to an inch. Sizes about 18 × 13 inches	0 2
33 †Index to the sheets of the 6-inch scale map, parishes coloured. England and Wales. Size 18 × 12 inches	1 0
Scotland. Size 24 × 18 inches	1 6
34.†Index to the sheets of the 1 : 2500 scale map, parishes coloured. England and Wales. Size 18 × 12 inches	1 0
Scotland. Size 24 × 18 inches	1 6
35. Nos. 33 and 34 are identical with Nos. 12 and 16, but with sheet lines added, printed on thin paper, and coloured to show civil parishes.	

* Publication in progress. † Publication stopped.

Before the paper, the PRESIDENT: I have to introduce to you the lecturer of the evening, Mr. Harrison, who has furnished one more instance of the advantages geography has drawn from love of sport. During the last twenty years, or nearly so, Mr. Harrison has been on various shooting expeditions, two of which were into the Rocky mountains, and he passed the winter of 1902–03 in the region of Great Slave lake. On his return home, Mr. Harrison determined to go through a course of surveying, in order to make his future travels more valuable from a geographical point of view. Accordingly, he went through a course under Mr. Reeves of our Society, and, thus scientifically equipped, he started on the journey which he is going to describe to us to-night, and which, I wish to remind you, was done entirely at his own expense. During that journey he has made a very large number of observations for variation of the compass, for latitude and for longitude, with occultations on five or six occasions, and he worked out the results on the spot, some of these observations with the thermometer 50° below zero. I will now invite him to read his paper.

After the paper, the PRESIDENT: I fear that we shall not have a discussion on the interesting points which Mr. Harrison has raised in the last part of his paper, because, so far as I know, there are not present to-night any Arctic experts who are willing to speak. We had hoped to have been honoured by the presence of Dr. Nansen; but he is suffering from a domestic bereavement, in which I am sure this Society will deeply sympathize. But I think that Mr. Harrison's paper can stand very well without discussion. It has been to me, and I am sure to you, extremely interesting, and we tender him our sincere thanks.

THE GORGE AND BASIN OF THE ZAMBEZI BELOW THE VICTORIA FALLS, RHODESIA.*

By G. W. LAMPLUGH, F.R.S., F.G.S.

The upper of the two cataracts is far less impressive, being merely a broad transverse band of comparatively shallow rapids, separated by protruding rocks. Between it and the lower cataract there is a wide basin of comparatively still water with slow eddies, and above it also the river has a slack current, and is bordered on the left by an extensive and exceptionally level flood-platform of rock. Mr. Sykes was informed that at this place "Batoka refugees were in the habit of crossing to the right side of the river in canoes, and thence making their way on foot to the small rocky island below the fall [seen in Fig. 9], which they used as a hiding-place from their enemies." †

Eastward from the Chimamba the country bordering the gorge on the north is so severely dissected that its plateau-character is almost lost; and, with the broadening of the valleys and the breaking down of

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* Continued from p. 152.

† There are many stretches of the river in the gorge where a strong well-manned canoe, if skilfully handled, might, I think, be navigated; and the flood-platform might afford a rough but practicable portage where the rapids are too formidable. But the risk would be great, and the presence of crocodile in all parts of the gorge that we visited is discouraging to adventure of this kind.

the intervening tabular ridges, there arises a conspicuous development of characteristic trap- or step-like features in the landscape, from the unequal weathering back of the successive outcrops of massive basalt and scoriaceous rock. Mr. Sykes's description of this country is as follows:—

"From the Chimamba onward for many miles the gorge is practically unapproachable, the neighbouring country being worse than anything yet experienced. That no one up to this time, except

FIG. 10.—THE LOWER CATARACT AT CHIMAMBA.
(*Photo by F. W. Sykes.*)

hunted fugitives, had attempted to penetrate into this very wilderness of rock and ravine is not surprising. After skirting round the head of this disrupted region, Koluja gorge is reached. This extends for about 3 miles in a north-westerly direction from the Zambezi. It is an immense cleft, being approximately 500 feet deep and about 250 yards across from surface to surface. . . . I attempted to follow the Chibongo [another northerly tributary] to its confluence with the main stream, but to no purpose. Its bed, between walls and steep hills, consisted of smoothly polished rocks, over which safe progress can only be made with

the utmost caution. After negotiating about $2\frac{1}{2}$ miles of this steeply shelving creek, all further advance was effectually checked by a series of almost perpendicular falls. During the rainy season this stream must be a succession of falls and cascades of more than ordinary beauty and variety.

"After another abortive attempt to reach the Zambezi, . . . I eventually succeeded in doing so by following the line of country between the Chibongo and the Kamadyango, making a *détour* over some difficult country by Suenani hill. Thence to the river was about 5 miles, and it was reached just at the spot where the Chibongo waters join the main stream. Immediately above are the Kwemani rapids, a very excellent view of them being obtained from this spot. The confluence of the Kamadyango is less than 2 miles down the river; and in between, a curiously shaped rock is met with, known to the natives as Kurusman. A somewhat similar one is also observable some distance down the gorge on the opposite side, which is called Sibarataan."

Again leaving the Zambezi at the Chimamba to avoid the roughest of this country, though still now always traversing irregular hilly ground in which the flat-topped ridges and kopjes were the only remnants of the original plateau, we made our next approach to the river some 15 miles farther eastward, by way of the tributary ravine of the Karamba stream, once more following the path of Mr. Sykes's previous exploration. This stream, in dropping from the plateau into a narrow cleft about 300 feet deep (which we named Kalonga's cleft), shows with peculiar clearness how the characteristic angularities in the drainage system of the country are developed. I have sufficiently described the conditions in my previous paper,* from which the accompanying sketch-plan, bird's-eye view, and section are taken (Figs. 11, 12, and 13).

FIG. 11.—SKETCH-PLAN OF THE KARAMBA RIVER, FROM ABOVE KALONGA'S CLEFT TO ITS CONFLUENCE.

(+ = View-point of Fig. 15.)

* *Quart. Journ. Geol. Soc.*, vol. 63, pp. 190–192.

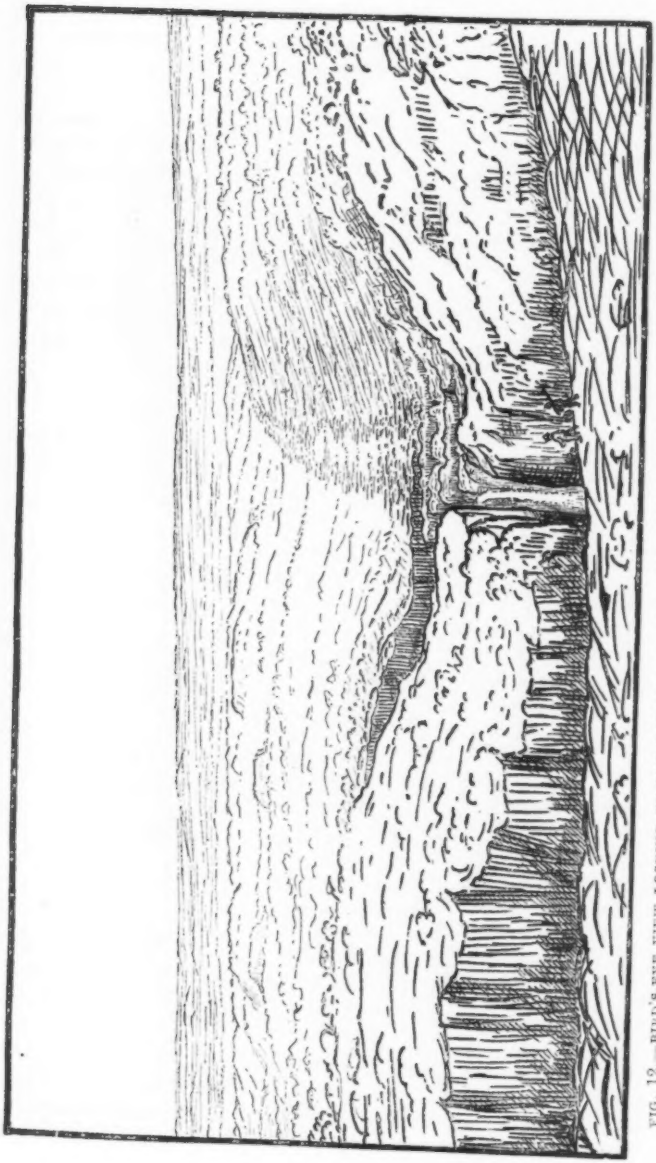

FIG. 12.—BIRD'S-EYE VIEW LOOKING UP THE KARAMBA VALLEY, WITH KALONGA'S CLEFT PARTLY VISIBLE IN THE FOREGROUND.
The dry-season stream is intercepted by a transverse gully (shown in section in the next figure), and is diverted to the left, but doubles back sharply and falls into the side of the ravine above Kalonga's Cleft.

It was with some difficulty that we found a practicable way of descent into the ravine of the Karamba.* But this accomplished, it was comparatively easy to scramble for 2 or 3 miles along the floor of its highly picturesque glen to its junction with the Zambezi (Fig. 14). There were signs, however, that the stream sometimes floods the bottom from side to side and rises many feet high against the confining walls; and in the rainy season these ravines, like the arroyas of the North American desert country, may be dangerous from the risk of sudden spates.

FIG. 13.—PROFILE OF THE KARAMBA RIVER-BED AT THE WATERFALL ABOVE KALONGA'S CLEFT.

At the Karamba confluence the sides of the Batoka Gorge are weathered down into long slopes, as shown in Fig. 15, but the valley is not much wider, nor in general aspect more conspicuous, than some of the tributary ravines with which the bordering country is intersected. In fact, the view from a high ridge above the sharp bend of the main river east of confluence revealed a confused maze of gorges, among which that of the Zambezi was distinguishable only by its broad ribbon of water.

Since leaving the Mavangu we had traversed an uninhabited country, and as supplies for our carriers were running short, we were compelled to press on by the quickest and easiest route, so that we did not again reach the Zambezi from the northern side till we arrived at Makwa. During the greater part of this four days' march our native guides declared that the river was at a long day's journey or more to the south of us. But if they had any definite knowledge of its position, which is somewhat doubtful (as they not unnaturally hold the network of gorges in dread), their estimate must, I think, have implied the difficulty of the route rather than the actual distance. At any rate, I saw, from a commanding view-point near our camp at 'Ntoro, the edges of a deep continuous ravine in the midst of a desolate wilderness at a distance of not more than 4 or 5 miles, which, from its direction and from subsequent observations, I suspect to have been the Batoka gorge itself, near its termination. But one would have had to reach the very crest of its trench before one could be assured, by the gleam of its waters, that the evasive river did indeed hold this course.

* Some alpine cord with which I was provided was occasionally of service in these descents, especially for preliminary exploration.

FIG. 12.—BIRD'S-EYE VIEW LOOKING [illegible]. The dry-season stream is intercepted by a transverse gully (shown in section in the next figure), and is diverted to the left, till [illegible] and falls into the side of the ravine above Kalonga's Cleft.

FIG. 14.—LOOKING UP THE KARAMBA VALLEY FROM ITS MOUTH: DRIFTED SAND FROM THE ZAMBEZI SHORE IN THE FOREGROUND.

(*Photo by F. W. Sykes.*)

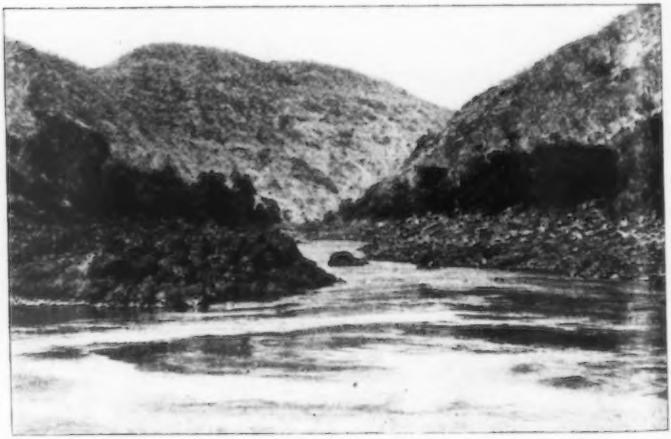

FIG. 15.—THE BATOKA GORGE, LOOKING DOWNSTREAM FROM THE CONFLUENCE OF THE KARAMBA.

(*Photo by F. W. Sykes.*)

From the northern side, therefore, the most easterly spot where we actually explored the gorge was at the confluence of the Karamba; but I afterwards reached it from the south at a place approximately 15 miles east of the Karamba. This was after we had ferried across the river at Makwa, and I had started afresh under the guidance of the late H. F. Greer to traverse a route over the plateau to Matetsi station. On the third day of this westward journey we diverged sharply north-eastward from the Lukunguli valley, and continued on this course until we neared the Batoka gorge. Our track lay across comparatively even country which sloped gently toward the Lukunguli until we were within 5 or 6 miles of the Zambezi, when we crossed a low rocky watershed and entered a much rougher stretch which drained directly northward. This direct drainage has probably been initiated by the excavation of the gorge, and is now eating backward into the older basin of the Lukunguli, which trends eastward, approximately parallel to that of the Zambezi. At the head of the new drainage, shallow rocky cirques have been developed, and lead downward into narrow chasms that fall abruptly to the main gorge. From the crest of one of these cirques to the bottom of the great cañon, according to my aneroid, the fall is about 836 feet.

We made a fatiguing but not difficult descent into the gorge over tumbled blocks and rainwash, down a crumbling spur overgrown with the usual dry bush. When we reached the bottom, our view was rounded off at a short distance both ways by the curves of the cañon, and the broad strand on which we stood seemed like a quiet island in the underworld. It was here that we saw on the strand the previously mentioned spoor of lion, along with that of several "buck;" and a huge crocodile floated basking in a smooth eddy. The river ran swiftly but noiselessly in a deep stream that at its narrowest was 90 yards wide. There are rapids not far distant, however, for at night the clamour of broken water from a lower reach could be heard at our camp on the crest of the gorge.

The persistence of the trench-like character of the valley down to this point, and its absence at not many miles farther down-stream, seem to imply that the sharp break between the low-level and high-level parts of the river, which now causes the Victoria Falls, was first developed in the portion of its course which lay above the confluence of the Matetsi.

Near the mouth of the Matetsi the main river, in its dry-season condition, forms a broad stream with deep pools, much frequented by the hippopotamus, and with many shallows interrupted by islets. Below the Matetsi confluence it is at first confined in a narrower, yet comparatively shallow, valley. Then it again expands, and at Makwa its aspect recalls the river scenery above the Victoria Falls—a tranquil stream about half a mile wide, flowing among well-wooded islands, in an open valley with irregular slopes, from which kopjes of no great

height here and there make salient projections (Figs. 16 and 17). This is the character of the river and its valley to a little below the confluence of the Deka; and then the hills close in upon it again and involve it in the wild lower gorge described with such depth of feeling by Major A. St. H. Gibbons.

FIG. 16.—THE ZAMBEZI VALLEY NEAR MAKWA (WANKIE'S DRIFT), LOOKING DOWNSTREAM FROM THE SOUTH SLOPE ABOUT A MILE ABOVE THE DRIFT.

(*Photo by Colonel F. W. Rhodes.*)

Relation of the Tributaries to the Trunk Drainage: Northern Tributaries.—On the northern side of the Zambezi, throughout the Batoka plateau, the subsidiary stream-system radiates outward from the highland of ancient igneous and metamorphic rocks that bounds the basaltic plain on the north-east, and this system is probably therefore of the "consequent" type. From the highland the streams flow north as tributaries to the Kafue river, and west, south-west, south, south-east, and finally east, as direct tributaries to the Zambezi. In the portion of this direct system crossed by our traverse, the average course of the tributaries swung round from south-west in the neighbourhood of Victoria Falls to south-south-east in the neighbourhood of Makwa. The streams in our path that appeared to belong to this consequent drainage were the Maramba (which has its confluence above the Victoria Falls, and, not having yet been rejuvenated, is graded down maturely to the main river), the Ungwesi or Kalomo (the latter name being preferable because of the confusion with another Ungwesi or Umgwesi farther westward),

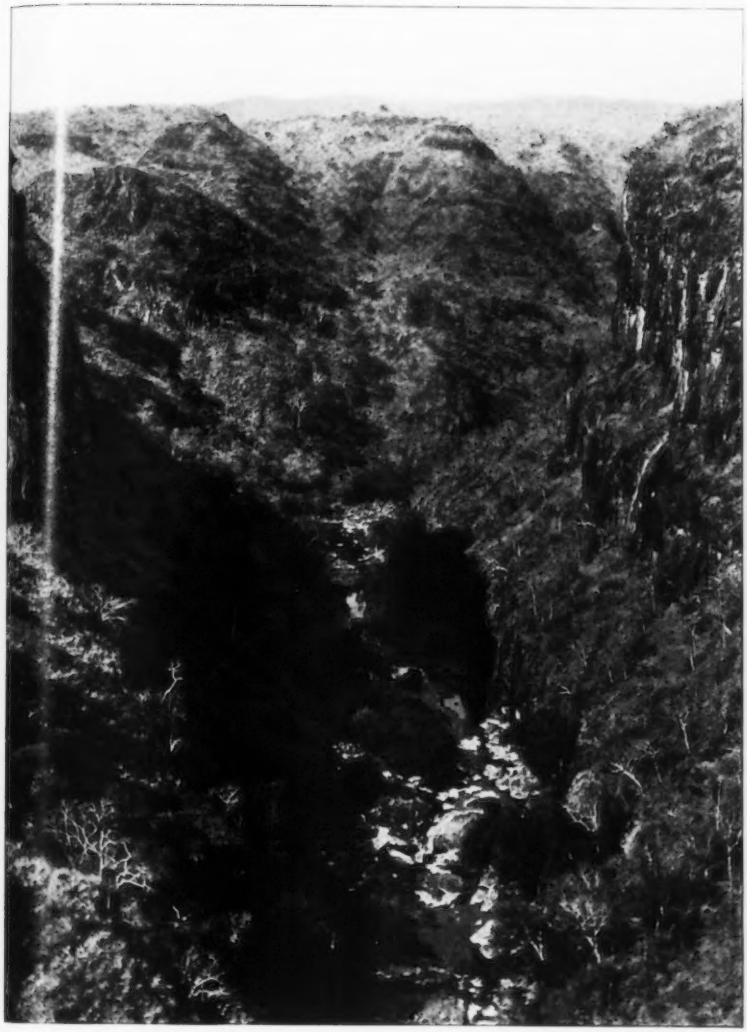

FIG. 17. The Ravine of a northern tributary, about 20 miles East of Victoria Falls.
(*Photo by F. W. Sykes.*)

the Namaruba, the Gwemansi, and perhaps the Bwani and the Chibongo (the last, not shown on my sketch-map, lying between the Mamba and the Karamba).

But besides these long-established tributaries, there are numerous smaller streams flowing directly into the gorge, that have probably been developed more recently, under conditions to which I have previously referred. In most cases these have begun as temporary rain-gullies on the flats in the immediate neighbourhood of the gorge soon after its excavation. By reason of their excessive gradient, and their picking out of the weakest vertical planes in the rock, these gullies have been extended backward rapidly into the plateau, and have soon developed small independent basins, which have broken into the territories of the older tributaries, sometimes even capturing and diverting them. The indications of these minor revolutions, in the form of truncated segments of older valleys, are numerous in all the dissected portions of the plateau, and are occasionally associated with a sprinkling of pebbles, representing ancient stream-detritus.

Many of the new streams still lie wholly within the rocky country along the rim of the gorge, but the sources of others reach back to the sand-bults that bound the rugged tracts on both sides of the Zambezi. The short newer streams all cease to run during the dry season; and even among the tributaries considered to belong to the original group, it is doubtful whether any within our traverse, except the Kalomo, maintains a perennial flow.

The natives have names for most of these watercourses; and among those west of the Karamba, noted by Mr. Sykes, but not shown on my sketch-map, are the Namburu, Chisonsi, Kengana, Musaki, Mara, Kasya, Mabombo, and Chikamba.

I have already described the ravine of the Songwi, which may be taken as a type of the habit of all these streams in their approach to the main gorge. The bird's-eye view of a segment of the Karamba valley, given in Fig. 12, p. 290, exemplifies their behaviour in descending from the plateau. The aspect of these ravines where they have been somewhat widened by weathering is as shown in Fig. 17.

Until we reached the Kalomo river we were able to cross all the northern tributaries above the place of their sharp descent. But this stream, by far the most important northern feeder that lay in our route, has carved out for itself a profound valley enmeshed by the ravines of its branches, the whole forming a complex basin of excessively rugged character, sinking deeply into the plateau. It happened, unfortunately, that my aneroid was rendered temporarily useless by an accident just before we descended into this wild basin, so that I was deprived of its aid in estimating the relative level of the stream at our camp in the bottom of the valley, but it was my impression that the Kalomo at our crossing-place had graded down its bed approximately to the new or

low-level position of the Zambezi, and that there was unlikely to be any considerable further fall between this place and its mouth. I regretted that circumstances did not permit me to follow this river both downward and upward, as its exploration would probably have yielded results of much interest both physiographically and geologically. The huge flood-bars of rolled stones in its bed contained evidence of wide diversity in the rock-structure of its upper reaches, and also showed how powerful its torrent must be when in spate. At the time of our visit (middle of July) the stream still maintained a flow greater than that of any other tributary of the Zambezi within the area of my traverses. We were just able to cross dryshod by selecting the biggest natural stepping-stones.

We mounted steeply out of the Kalomo basin on its eastward side by the coombe-like valley of the Knongu, one of its many branches, and after traversing a complicated stretch of broken ground, due to the influence of the low-level Kalomo drainage, we again reached the comparatively level plateau. Our next three streams, the Namaruba, Gwemansi, and Iburumansi, were all crossed where they ran feebly in relatively shallow valleys of the plateau-type.

The Kalomo (Ungwesi) is the only tributary shown in this part of the country on the B.S.A. Co.'s map; but the three streams above mentioned are evidently those indicated farther northward on the map in Major A. St. H. Gibbons' 'Africa from South to North' (vol. 1), as having been crossed in the route followed by Captain G. Hamilton and Major F. J. Quick in 1899. The "Maroba" river of this map is doubtless that for which we obtained the name "Namaruba"; the other two, and also the Bwani further eastward, are shown without names.

From some glimpses of the distant country to the northward that I obtained in this district, and from geological indications, I suspect that the heads of the basins of the Namaruba and Gwemansi have been encroached upon by aggressive eastern feeders of the low-level Kalomo river.

Southern Tributaries.—There is a remarkable difference between the subsidiary drainage-system of the basalt country to the south of the Batoka gorge and that to the north of it, for the courses of the northern streams in the district examined make a wide angle with the main river, whereas the chief southern tributaries within the same longitudes trend towards the Zambezi at an acute angle. Indeed, some portions of the courses of these latter tributaries or of their feeders follow a direction approximately parallel to that of the main river. Moreover, the deeply sunk basins of the chief southern tributaries are much more expanded than those of the northern streams (with perhaps an exception in the case of the Kalomo), or even, as it seemed to me, than that of the Zambezi itself in the same longitudes. Thus, the Batoka gorge, wherever I saw it, forms in cross-section a simple though deep notch in the plateau, with mere traces of a shallow outer valley occasionally

associated with it; while the basins of the Deka and Matetsi form broad depressions, in which there has been a general lowering of the plateau over a wide extent of country, associated with inner ravines of relatively small dimensions. Indeed, the basin of the Matetsi appeared to me to be the chief factor in the physiographical shaping of the country south of the Batoka gorge, its northern rim parallel to the Zambezi having gained so far northward that the direct drainage to the main river is confined within very narrow limits.

Our knowledge of the region is perhaps still too scanty to warrant the interpretation of its structure, but we may, at any rate, recall one obvious reason for the conditions above mentioned. Both the Matetsi and the Deka join the Zambezi below the end of its gorge, and their low-level outlets are therefore of high antiquity; so that during the whole time that the main river has been carving out its cañon, these tributaries have been lengthening and widening their nearly parallel basins in the plateau, thereby drawing more and more of the upland drainage within the sphere of their influence, and perhaps even robbing the Zambezi itself of some of its sluggish unrejuvenated feeders.

But now the conditions are again altered; the gorge has reached backward beyond the basin of the Matetsi; the short direct streams of precipitous gradient, vigorously at work, are beginning to encroach upon the inward slopes of the aggressor, and the factors that tell in the competition are reversed. The Masui river, especially, that joins the Zambezi from the south 3 or 4 miles below the Victoria Falls, though as yet it has had time to develop the full effect of its rejuvenation only for a very short distance above its mouth, has a promising future, boding mischief to the western flank of the Matetsi system. But at all times, whichever system gains, the plateau always loses.

Consequent upon the obliquity in direction and relative maturity of these southern tributaries, it happens that a profile-section drawn southward at a right angle from the middle portion of the Batoka gorge to the margin of the Kalahari desert will intersect at least three wide depressions—the first containing the Lukunguli, an important feeder of the Matetsi; the second, containing the Matetsi itself; and the third, containing the Deka river.

It is noteworthy that this subparallel stream-system appears to be restricted to the basaltic country, and to that portion of it which has been longest under dissection. On the east it is not maintained by the Gwai, which flows approximately northward from an upland of older rocks; and on the west it ceases with the Masui, which also appears to hold a general northerly course, though swerving eastward for a few miles above its confluence. Probably the prevalence of east-and-west planes of weakness in the basalts, to which I have previously referred,* has

* For fuller discussion and illustration of the effect of these planes on the drainage see my previous paper, *Quart. Journ. Geol. Soc.*, vol. 63, pp. 187–192.

been the predominant factor in this matter, its effect becoming progressively greater in proportion to the antiquity of the low-level drainage. If this be so, the streams in question in their present form are "subsequents," and may depart widely from earlier conditions.

Though the cartography of the region south of the Batoka gorge is well in advance of that of the northern side, it is yet very imperfect, and, except along the route of the new railway, still depends mainly upon the maps of those great pioneers, James Chapman and Thomas Baines, published nearly fifty years ago.* Their mapping of the Matetsi † basin shows much detail, and has not been improved by the interpretation of it given in recent maps (*e.g.* The B.S.A. Co.'s "Rhodesia," on the 1 : 1,000,000 scale, sheet 5). ‡ The lower portion of the Matetsi is named the "Mapako river" on Chapman's map, and the "Makapo" on that of Baines, but neither name appears now to be known to the natives. In endeavouring to revise their results I was fortunate in having the assistance of the late Mr. Greer, whose knowledge of the native tongue was essential to my object.

At Makwa (Wankie's drift) I was able to identify "Logier hill," the site of Baines' disastrous encampment during his attempt to build boats in which to navigate the Zambezi (see Fig. 18). We were guided to this place by two old natives who recollected the circumstances well, though they could only tell of two white men there—Jabomani (presumably Chapman) and Jantoni (Anthony, the young Boer)—and did not seem to remember a third.

The stream-bed west of this kopje, dry at the time of our visit, shown as Logier river on Baines' map, is known to the natives as the Gongobujo. The view reproduced in Fig. 16 (p. 294) looks across the delta of this tributary. Our route followed up this stream-bed for 2 or 3 miles, and then crossed a broad high-lying sand-bult, from which we descended steeply into the valley of the Matetsi about 4 miles above its confluence, where it has a somewhat wide floor, not far above Zambezi-level, and is lined with alluvial terraces, cultivated by the natives. According to Mr. Greer, the name of the river, to be in keeping with the native pronunciation, should have been transliterated "Matezi" (which would also have served to distinguish it from the northern Matetsi, a feeder of the Kalomo river). But as the latter spelling has been adopted officially for the station and post-office where the railway crosses the river, it will now stand.

On our westward march from the mouth of the Matetsi we rose

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* J. Chapman, 'Travels in the Interior of South Africa' (London: 1868); and T. Baines, 'Exploration in South-West Africa' (London: 1864).

† Spelt "Matetsie" by Chapman, and "Mateitsie" by Baines.

‡ Published by E. Stanford, London.

quickly for about 450 feet to a wide spur of the plateau, and then as rapidly descended into the broad deep valley of an important east-flowing feeder of the Matetsi, which we followed up for two days to its head. In the lower part of this valley, the river (which at the end of July still maintained a strong flow of water) is known to the natives as the Lukunguli; but the dry stream-bed on the undulating plateau that we followed during the second day was called the Jambezi. I am a little uncertain, however, whether this watercourse constituted the main head of the Lukunguli, or whether it is one of the branches.

There can be little doubt that the Jambezi-Lukunguli is the stream

FIG. 18.—THE ZAMBEZI RIVER AT MAKWA (WANKIE'S DRIFT), WITH LOGIER HILL IN THE BACKGROUND.

(*Photo by F. W. Sykes.*)

indicated on the maps of Chapman and Baines as the Myatambesi. Its continuance eastward was left somewhat uncertain on their maps; but it was supposed to flow independently to the Zambezi, and to have its confluence a little to the northward of that of the Matetsi. From a view-point at the mouth of the Matetsi I saw a side-valley in approximately the position of the supposed confluence of the Myatambesi, but this must belong to a stream of the short direct type, and not to the Lukunguli, for the latter river joins the Matetsi 10 or 15 miles above its mouth. On the B.S.A. Co.'s map the Myatambesi is rightly shown as a feeder of the Matetsi, but, presuming it to be the Lugunguli, its course is quite incorrectly represented.

Like all the larger southern streams, the Lukunguli heads on the plateau in wide grass-covered loam-flats, which form a shallow basin bounded by higher forested sand-veld. On the north this sand-veld separates the basin from the direct Zambezi drainage, and on the south it spreads across the subsidiary watershed and covers a large part of the long descent into the main basin of the Matetsi. The alternation of loam-flats and sand-bults, with occasional interspaces of rocky ground, is the prevalent characteristic of the less broken portions of the plateau, as I have elsewhere described * and illustrated by the figure here reproduced (Fig. 19).

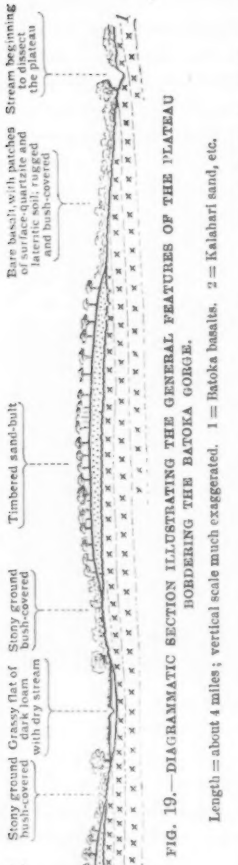

Sand-bult
Stony ground bush-covered
Grassy flat of dark loam with dry stream
Stony ground bush-covered
Timbered sand-bult
Bare basalt with patches of surface-quartzite and laterritic soil; rugged and bush-covered
Stream beginning to dissect the plateau
1
2

FIG. 19.—DIAGRAMMATIC SECTION ILLUSTRATING THE GENERAL FEATURES OF THE PLATEAU BORDERING THE BATOKA GORGE.

Length = about 4 miles; vertical scale much exaggerated. 1 = Batoka basalts. 2 = Kalahari sand, etc.

The mapping and nomenclature of the middle reaches of the Matetsi with its tributaries also require rectification, toward which, however, I can contribute little. What was considered by Chapman and Baines—correctly, as I think—to be the main stream, receiving numerous feeders from the south, is shown on the official map as the Machumpa river, and the Matetsi is given an independent course farther westward. The error has probably arisen from a misinterpretation of a sharp bend in the Matetsi, some 3 miles west of the railway-crossing, which appears to bring the river in from the north-west; but we found that another bend toward the opposite quarter soon counteracted the effect of the first. The natives whom we questioned knew the Machumpa only as a small spruit, tributary to the Matetsi.

The Chichigumba river of my sketch-map is that shown as the Chinjagumba on the official map. It is probably the largest of the upper feeders of the Matetsi, and indeed appeared to me to be at least equal in consequence to the Matetsi near their confluence. In direction and in the features of its basin, it bears much resemblance to the Lukunguli, except that the comparatively high level of its confluence prevents its valley ever attaining the abruptness and depth of that of the lower Lukunguli.

* *Quart. Journ. Geol. Soc.*, vol. **63**, pp. 169–170 and fig. 1.

On our rapid southward journey from Lukubiro's kraal (Jaraban's kraal of the B.S.A. Co.'s map) in the Chichigumba basin to the head of the Deka valley, we crossed the Matetsi river not many miles below its head. Here it had no definite valley, but was merely a trickling stream, with long narrow water-pools, confined by low banks on an open plain. Some of its little feeders, however, have excavated irregular valleys in the higher country to the southward, where flat-topped ridges rise against the sky-line.

The broad high strip of tree-covered sand-veld, called by Chapman the "High land of Boomka," that lay across our route between the upper basin of the Matetsi and that of the Deka, may be regarded as a northern spur of the Kalahari that has not yet been broken up by the tributary drainage of the Zambezi system. It holds the characteristic shallow pans or vleys, with no outlet, which contain water for a short time during the wet season; and at its southern edge we passed a small pit-like water-hole of the Kalahari type, sunk 8 or 10 feet below the general level. The descent from this country to the Deka basin was very gradual, but unfortunately it was night before we reached that river, and darkness hid the transition from me.

The Deka basin, so far as it lies within the basalts, is generally similar to that of the Matetsi. Its south-eastern side is, however, of different aspect, as a result of the sudden change in the country-rock from basalt to sandstones and coal-bearing shales along the great "Deka fault;" * and on this side, the valley is fringed with tabular kopjes that become relatively higher and more rugged as the basin becomes deeper. It appeared to me that the average direction of the Deka river from its headwaters to beyond the Wankie coalfield is approximately east-north-east, and that it is placed too far southward on the recent maps, which give it a north-easterly course. But my observations were not of a character to enable me definitely to fix its position.

Concluding Notes.—A more particular and localized description of the plateau and of the country generally along our routes will be found in the short itinerary printed as an appendix to my paper on the geology of the region (*op. cit.*, pp. 213, 214). It may be added that the hazards of the country to the traveller are increased by the great scarcity of conspicuous features to serve as landmarks where the plateau is unbroken, and by the general similarity of the ravines where it is dissected. South of the Matetsi, however, on the southern side of the Zambezi, and east of the Gwemansi on the northern side, where the ground has been more broadly carved away, there are usually hills of recognizable shape when a distant sky-line is in sight.

The average level of the plateau falls decidedly toward the Zambezi both from the north and from the south, and it also sinks eastwards

* *Quart. Journ. Geol. Soc.*, *op. cit.*, pp. 178–180, and figs. 2 and 3.

until the Deka is reached. These gradients probably pertain to its original structure, but have been greatly accentuated by erosion. If it should ever be worth planning irrigation on an extensive scale in the Zambezi basin, water could therefore be conveyed by gravitation from above the Victoria Falls to the more easterly portion of the plateau and its valleys.

I append a series of aneroid readings taken at intervals along our route. Though not likely to have much value as absolute measurements of altitude, they will serve as indications of the relative levels. The weather remained uniformly placid throughout our journeys—cold nights and bright hot days with clear skies, except on three days when scattered packs of white cloud sailed up in the afternoon.

For the photographs with which this paper is illustrated I am indebted to the kindness of Mr. F. W. Sykes, and of Miss Louisa Rhodes (acting as the representative of her brother, the late Colonel F. W. Rhodes, who accompanied us on our journey north of the gorge). I have also to thank the Council of the Geological Society for permission to reproduce Figs. 8, 11, 12, 13, and 19; and the Council of the British Association for the same privilege in Fig. 1.

Approximate Altitudes, from Aneroid Observations, in the Zambezi Basin around the Batoka Gorge.

Note.—The instrument used was a Stanley's $2\frac{3}{4}$-inch aneroid, compensated. In the altitudes given below, the actual readings have been adjusted in accordance with fixed levels on the Bulawayo-Victoria Falls railway at the places where I could compare these with the results yielded by the instrument. The figures can be approximations only, but the instrument gave fairly consistent results throughout.

For the following supplementary altitudes I am indebted to the officers of the Rhodesia Railway Company: *Victoria Falls railway station*, 2994 feet; *Victoria Falls bridge* (rail-level), 2876 feet; *Kesi siding* (on plateau north-west of Matetsi), 3489 feet; *Matetsi station*, 2804 feet; *Katuna siding* (between Matetsi and Deka bridge), 2987 feet; *Deka bridge*, 2292 feet; *Wankie station*, 2448 feet; *Bulawayo*, 4469 feet.

I was informed by Mr. G. C. Imbault (who had charge of the construction of the Victoria Falls bridge) that a measurement of the middle portion of the Victoria Falls by triangulation gave the height as 357 feet; the dry-season water-surface in the gorge beneath the Falls will therefore be at an altitude of 2540 feet.

The altitudes are in feet above sea-level (Cape datum).

Where the opportunity occurred, readings were taken at different hours, and in these cases the average is given, and the number of separate observations is indicated by the figures in brackets.

THE BATOKA GORGE.

Locality.	Crest of the gorge, or nearest available point on the plateau adjacent.	Bottom of the gorge, usually on the flood-platform.	Remarks.
	Feet above sea-level.	Feet above sea-level.	
Victoria Falls	2900	2540	See note above.
Near confluence of Songwi river	(6) 2680	(2) 2220	Depth of gorge, 469 feet.
Mavangu camp	(3) 2830	—	
Chimamba cataracts	(3) 2430	1780	„ „ 650 feet.
Highest point on route between Mamba river and Karamba river	2720	—	
Karamba camp and confluence ...	(7) 2450	1630	„ „ 820 feet (but less at actual crest).
Opposite to Namaruba confluence (south side of gorge) ...	(2) 2420		
In hollow on crest at south side of gorge	(2) 2280	(2) 1590	Depth of gorge, 830 feet.
At Matetsi confluence	—	1470	
Makwa (Wankie's drift) ...	*	(3) 1440	* Baines gives 1550 feet for his camp on Logier hill; and Mohr, 1680 feet for Wankie's kraal.

MATETSI BASIN (GOING UPSTREAM).

Locality.	Feet above sea-level.
Sand-bult between Gongobujo river and Matetsi river	2180
Cheza's kraal, in Matetsi valley, 4 miles above mouth	(4) 1590
Plateau in north angle between Matetsi and Lukunguli rivers ...	(4) 2020
Siantete's kraal, in Lukunguli valley	(4) 2220
Dambi's kraal, at head of Lukunguli valley	(2) 2790
Watershed between Dambi's kraal and Matetsi railway-station ...	3040
Matetsi river at ford, 4 miles west of Matetsi station	2850
In north angle between Matetsi and Chitshigumba rivers	(2) 3080
Lukubiro's kraal (formerly Jaraban's), Chitshigumba valley ...	(2) 3210
Matetsi river at highest crossing, near Pandamatenka road	(2) 3180
South side of Matetsi basin, near its head, at Matheison's	(3) 3380
Boomka sand-bult, between Matetsi and Deka basins	(2) 3620

DEKA BASIN (GOING DOWNSTREAM).

Locality.	Feet above sea-level.
Upper valley, near Deka	(4) 3450
First camp in valley below Deka	(3) 3390
Bumbusi camp, south-east side of Deka valley	(2) 2870
Mtoro's kraal (between Bumbusi and Ngoni's)	(2) 2530
Ngoni's kraal, on low terrace of Deka river	(2) 2390
Deka railway bridge (see above)	2292
Deka valley at Rondulu confluence, 6 miles north of Wankie station	2150
Makwa (Wankie's drift), near mouth of Deka river (see above) ...	1440

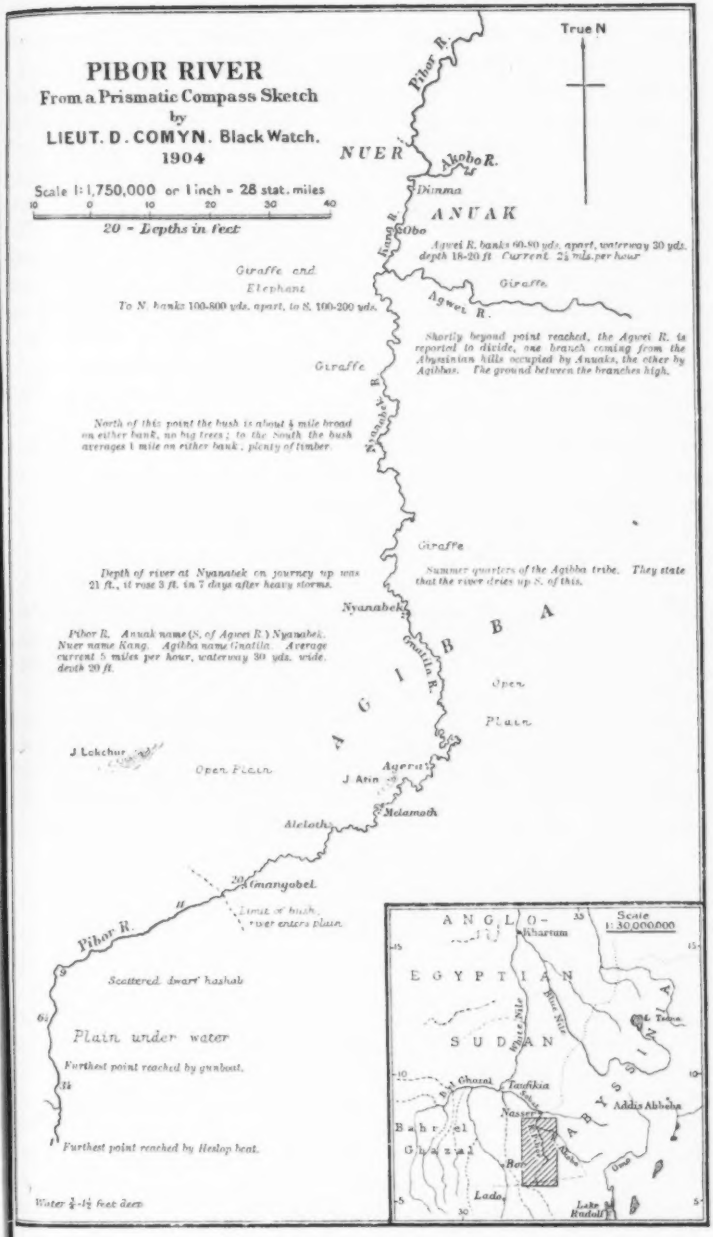
LIEUT. COMYN'S SURVEY OF THE PIBOR RIVER.

One of the principal upper branches of the Sobat has for some years been known to be the Pibor, which joins the Akobo from the south a little short of 8° N. lat. It was ascended a short distance by Lieut.-Colonel (then Major) Maxse in 1898, but, owing to difficulties caused by the sudd, little further was done to explore its course until, in 1904, a successful ascent to a point far to the south was made by Lieut. Comyn, of the Black Watch, in the gunboat *Abu Klea* (apparently the same in which Major Maxse had visited the river). Lieut. Comyn has sent us a detailed account of his voyage, accompanied by a copy of his survey, which is here reproduced on a smaller scale. The following notes embrace the most interesting parts of the narrative.

The amount of sudd appears to have been less than usual in August,

THE PIBOR RIVER.

1904, the month in which the ascent was begun. After passing his predecessors' farthest, Lieut. Comyn steamed across a lake-like expansion covered with thin sudd, and soon found a clear stream, about 20 feet deep, running between banks about 200 yards apart, crowned with a belt of thorny bush, beyond which lay a large treeless plain, with a line of *heglig* trees (*Balanites ægyptiaca*). A herd of elephants was seen, as well as other game, including giraffe in extraordinary numbers, all being very tame. A belt of sudd had to be cut through, and beyond this the waterway dwindled to from 20 to 50 yards, though the belts of bush were still 100 yards apart. About 50 miles beyond the mouth of the Agwei, traces of human inhabitants were seen in the shape of rude shelters about 3 feet high, with fishing-baskets, etc., lying about. Leaving the chief engineer, Mr. Sharples, to superintend the cutting


PIBOR RIVER
From a Prismatic Compass Sketch
by
LIEUT. D. COMYN. Black Watch.
1904
Scale 1:1,750,000 or 1 inch = 28 stat. miles
10 0 10 20 30 40
20 = Depths in feet
True N
Pibor R.
NUER
Akobo R.
Dimma
ANUAK
Kang R.
Obo
Agwei R. banks 60-80 yds. apart, waterway 30 yds. depth 18-20 ft. Current 2½ mls. per hour
Giraffe and Elephant
To N. banks 100-800 yds. apart, to S. 100-200 yds.
Giraffe
Agwei R.
Shortly beyond point reached, the Agwei R. is reported to divide, one branch coming from the Abyssinian hills occupied by Anuaks, the other by Agibbas. The ground between the branches high.
Nyanabek R.
North of this point the bush is about ¼ mile broad on either bank, no big trees; to the South the bush averages 1 mile on either bank, plenty of timber.
Giraffe
Depth of river at Nyanabek on journey up was 21 ft., it rose 3 ft. in 7 days after heavy storms.
Summer quarters of the Agibba tribe. They state that the river dries up S. of this.
Nyanabek
Pibor R. Anuak name (S. of Agwei R.) Nyanabek. Nuer name Kang. Agibba name Gnatila. Average current 5 miles per hour, waterway 30 yds. wide, depth 20 ft.
Gnatila R.
AGIBBA
Open Plain
J. Lokchur
Open Plain
Agerat
J. Atin
Melamoth
Aleloth
Kimanyobel
Limit of bush, river enters plain.
Pibor R.
Scattered dwarf bashab
Plain under water
Furthest point reached by gunboat.
Furthest point reached by Heslop boat.
Water ¾-1½ feet deep
ANGLO-EGYPTIAN SUDAN
Scale 1: 30,000,000
Khartoum
White Nile
Blue Nile
L. Tsana
Ghazal
Taufikia
Nasser
Addis Abbeba
Bahr el Ghazal
Bor
Lado
Lake Rudolf
ABYSSINIA

through another belt of sudd, Lieut. Comyn went on in the launch, and came upon inhabitants, who at first deserted their village, which lay behind a belt of trees, and proved to bear the name Nyanabek. Relations were at length established, after some hostile demonstrations had been quieted by the firing of a gun, which produced a great effect. The people, who gave their name as Ajibba, seemed to be a strongly organized tribe, at feud with the Nuers, whom they hold in great respect while despising the Anuaks. In appearance they are unlike either of these, being more like the peoples of the western Bahr-el-Ghazal. The average height seemed to be about 5 feet 6 inches. The young men had their hair arranged like an inverted soup-plate, the front portion being cut off. Across the forehead they wore a band ornamented with beads, and from the centre of the under-lip depended about 8 inches of chain or thin wire. Rings were worn in the ears, and on the arms armlets and rings of ivory, rhinoceros-horn, and metal. A small carved stool, which also served as a head-rest, was carried under the arm. The wrist-knife and spears had their edges encased in sheaths of giraffe leather. The older men wore a bowl-shaped hat of felt, and a large tuft of giraffe-tails just above the elbow. In conversation they had a strange way of arranging their persons according as they listened or spoke, before doing which last they rang a bell which they carried. The Ajibba seemed to possess a good number of cattle and sheep, and cultivated durra and tobacco. They appeared quite ignorant of weaving, and nothing resembling cloth was seen among them, but their leather-work gave evidence of much skill.

Beyond Nyanabek the gunboat steamed past a number of villages consisting of five or six huts each. The bush soon closed in on the river, but was submerged to a depth of several feet. A hill was sighted, which formed a landmark for many miles. The waterway became narrow and excessively tortuous, with an almost imperceptible current, and at last became quite closed by sudd, but by casting off the sandal (barge), it was found possible to force the gunboat through. On emerging into a broader channel, the water appeared whitish, probably owing to a storm on the plain beyond. The trees hereabouts changed from *nebbuk*, *kuk*, etc., to little else than *takl*. More villages of Ajibba were reached, but the people showed themselves hostile, though they gave the information that the hill above mentioned was named Atin. The course led past the foot of this, and another mountain was soon sighted. The river broadened into a lake-like expanse, with a treeless plain to the north and west, and slightly rising ground to the south. Fuel was now almost at an end, but an attempt was made to push west, in which direction the plain was traversed by a band of light-green grass, with here and there a space of open water. Fortunately, when the last pound of fuel was being used, a wood of *takl* trees, waist-deep in water, was reached, from which a fresh supply was obtained by three days'

hard work. The wood was alive with birds, mostly black, and of the size of large ducks, producing an extraordinary spectacle. Very soon afterwards the increasing shallowness and the thick grass made further progress in the gunboat impossible, but having sighted a forest in the distance, Lieut. Comyn started for it in the Hislop boat, and when even this could be poled no further, did the last few miles by wading. The boat was once more reached at nightfall, and was only found thanks to the precaution which had been taken of tying a sheet to the mast. The wood which had been reached, consisted of enormous *heglig* trees, and contained many birds' nests, but the eggs—of the size of a turkey's—some of which were boiled and eaten, proved most unpalatable.

During the return voyage the hill Atin was climbed, and from its top the course of the river could be traced for miles. It appeared to lie in a belt of bush, but to be nowhere joined by any other stream. The hill was composed of a red and black granite. The Ajibba in its neighbourhood declared that their tribe extends to the Abyssinian hills, and that they also dwell on the Agwei. Progress down-stream was comparatively easy, and on reaching the Agwei, Lieut. Comyn decided to explore it in the launch. Within the mouth he found it a fine river, 18 feet deep, and running for the most part between banks several feet high. Some belts of sudd had to be negotiated, but only one seems to have caused serious trouble during the ascent, though the difficulties were somewhat greater on the return. On the banks bush and plain alternated, with some fine trees, but at one part the country was flooded. Giraffe were seen, and many egrets and other birds. One of the crew was wounded by a crocodile, and on reaching a solid mass of sudd between high banks, Lieut. Comyn was forced to turn, reaching the steamer after an absence of three days, and proceeding at once to the Nasser post, where much-needed supplies of flour, rice, and sugar were procured.

DR. RICE'S EXPLORATION IN THE NORTH-WESTERN VALLEY OF THE AMAZON.

By Colonel GEORGE EARL CHURCH.

Between the Rio Negro tributary of the Amazon and the Andes is one of the most interesting and unknown regions of South America, replete with unsolved geographical problems. It is traversed by numerous great rivers, which have their sources on the eastern slopes of the Cordillera south of Bogotá. Some of these streams have been partially although rudely explored. I have called especial attention to this vast area of country in my 'Desiderata in South American Exploration,' published by our Royal Geographical Society last year, as offering a splendid field of geographical study for some hardy and adventurous explorer. My friend Dr. H. Rice, a graduate of Harvard University,

has found the bait too alluring to resist, and, at his own expense, is, with rare courage and intelligence, now unravelling, as it were, the confusion that exists regarding the sources of the Guaviare, the Ynirida, the Rio Negro, and the Uaupes. The following letter, which I have just received from him, will give a faint idea of the magnitude of the work to which he is devoting his energies and resources :—

"La Sal, Rio Guaviare, Colombia, November 5, 1907.

"My dear Colonel,

"There is a canoe just starting for San Martin, and I take this opportunity to send you a line. I reached Unilla September 29, which river is the north branch of the Uaupes. I was there a month, and I returned here in order to place the source of the river Ynirida, which is eight days to the east of here. The Rio Negro rises in the hills just south of Puerto Alturo, which is at the point where the Rio Ariare debouches into the Guaviare, five hours above here by canoe, and from where I started through the Vega de Caqueta to the Uaupes. I am returning there to-day or to-morrow for more observations, and also to study the hills more carefully, as I think that they are the remnant of coast-line of the ancient Amazonian sea, the evidence of which I shall submit to you later. I return soon to the Unilla, and thence descend to the river Itilla, stay there awhile, and then go down the Uaupes very slowly.

"The so-called Vega here is a dense forest, rich in rubber, and watered by hundreds of *caños* (natural canals), which contribute to the difficulties of travel.

"I have acquired a vocabulary of 100 words or so of Carigona, Huilote, and Anagua Indians, and have a great fund of things to tell you when we meet.

"I enclose two maps which I have just drawn, very hastily. They are not to scale, but may give you an idea of how things are situated here from a cartographical point of view.

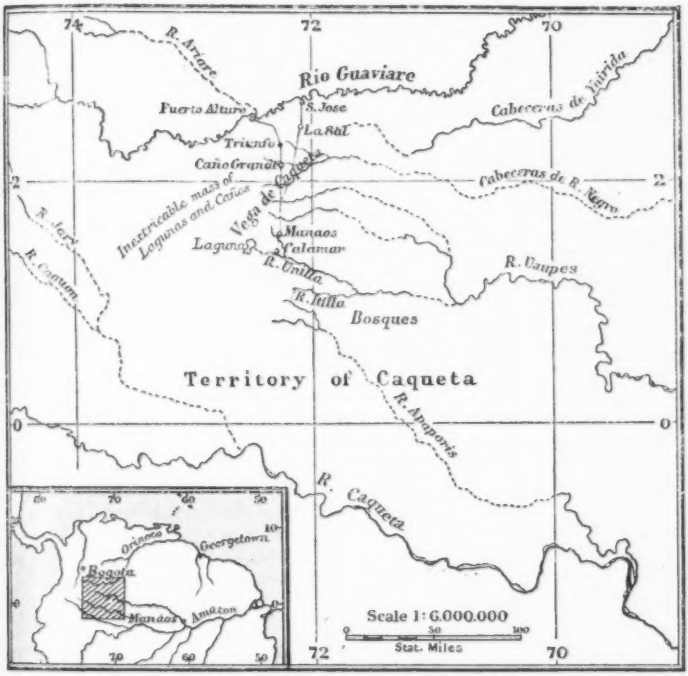
"I am going very slowly, studying everything carefully, and coming only to conclusions after long meditation. If I am in doubt about anything, I return to work over it again. I have compared Broca's scale of colour with every Indian I have seen, and they are a light brown-yellow or dark olive invariably. The eyes are markedly Mongolian, and the face broad and flat, and many points to make us think them having migrated from elsewhere, but the more I see of them the more I am convinced that they are the product of the soil here, the same as any long-isolated organism. I have followed up their religion, etc., and all these points you shall have later.

"Yours sincerely,

"Hamilton Rice."

Up to the present time, the river Unilla has been mapped as a

branch of the Guaviare affluent of the Orinoco, according to the explorations of Crevaux, but Dr. Rice makes it the north branch of the Uaupes, thus extending the drainage basin of the Amazon to within about 90 geographical miles of the city of Bogotá. Wallace, who explored the lower Uaupes, a great western branch of the Rio Negro, was "strongly inclined to believe" that the Ariari and other rivers credited as sources



ROUGH SKETCH-MAP TO ILLUSTRATE DR. H. RICE'S EXPLORATIONS IN THE NORTH-WEST AMAZON REGION, 1907.

of the Guaviare, were in reality those of the Uaupes. His supposition was incorrect as regards the Ariari, but as to the Unilla is confirmed by Dr. Rice.*

It seems that Dr. Rice is now about to complete the exploration of

* Dr. Koch of Berlin, who in 1904 ascended the Uaupes farther than any of his predecessors (*Zeitschrift*, Berlin Geographical Society, 1906, pp. 89-91), found it still an imposing stream in 71° W. He was told that four days higher up it was formed by the junction of two streams, one from the west, the other from the north, which would seem to be the Itilla and Unilla of Dr. Rice. Dr. Koch says that the Umauas, a tribe of Carib stock, roam over this region. The Unilla of previous maps is, it should be noted, the stream shown in our sketch-map as joining the Guaviare just west of 74°.

this river, and we cannot but wish him every success in his dangerous but extremely important task. In his letter, above quoted, he mentions a tribe of Indians, the Anaguas, but I am not quite sure whether the word commences with A or O. It may be Omaguas, which would make them a fragment of the race of this name which once occupied such a vast region on the upper Amazon and the rivers of Ecuador. If some of them are still found at the headwaters of the Guaviare, it is interesting to ethnologists.

REPORT OF PROGRESS IN THE INVESTIGATION OF RIVERS.*

By A. STRAHAN, Sc.D., F.R.S.

This investigation was commenced in 1906 by aid of a Government grant of £150 per annum for three years, supplemented by a grant of £50 by the Royal Geographical Society. The object is to ascertain—

(*a*) The discharge of rivers in winter and summer, and the total annual discharge.

(*b*) The suspended and dissolved impurities in wet and dry periods, and the total amount carried in the year.

(*d*) The rainfall in different parts of each river-basin.

(*e*) The area of each basin, and the elevation of different parts of it.

(*f*) The area occupied by calcareous and non-calcareous formations, and by pervious and impervious formations.

At my invitation, Dr. A. J. Herbertson and Dr. H. R. Mill joined me as a committee, the latter undertaking to furnish records of the rainfall. Subsequently, Mr. N. F. MacKenzie consented to become a member of the committee, and to give the benefit of his wide experience in gauging rivers and canals in India.

The committee have had also considerable assistance from Mr. E. F. Elton and Mr. H. O. Beckit in many branches of the work, more especially in levelling, sounding, and measuring river-channels, in tracing water-partings, and in the computation of areas.

To Prof. W. H. Lewis, of the Albert Memorial College, Exeter, the committee is indebted for periodical examinations of the suspended and dissolved impurities in the Exe.

The Exe and its Tributaries.

Work was commenced on the Exe. The Exeter City Council, in reply to a letter describing the nature of the investigation, promised assistance in every possible way as far as it related to this river. A gauge, furnished by the committee, was fixed by Mr. Thomas Moulding, the city surveyor, at Exeter quay, and is being read daily by one of his staff. The river is here confined to a single channel of fairly uniform breadth and depth, and seemed suitable for determinations of volume. The channel was therefore sounded for a measured length of 100 feet, and velocity-observations have been made as frequently as possible. A record of floods since 1866 has been kept at a boat-house close by. By levelling from the flood-marks to the gauge the committee has been able to add this record to its recent observations.

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* Research Department, November 15, 1907.

About 5 miles above Exeter, the Exe receives the Creedy on its right bank, and the Culm on its left bank. Gauges have been erected on both of these rivers, and on the Exe above the confluence, and are being read daily. Velocity-courses have been measured on the Creedy and the Exe close to the gauges, and observations on the current have been made when practicable. The course on the Exe seems to be satisfactory, but that on the Creedy may have to be changed, inasmuch as flood-water of the Exe may under certain conditions run up the Creedy as far as the spot selected. The Culm presents considerable difficulties, for when in flood it spreads over a broad alluvial flat and fills a number of temporary channels. The best method of dealing with this stream is still under consideration. In the mean time the gauge is read daily by Mr. Charles Gray, engineer to the Silverton Paper Mills, who has kindly also consented to collect samples of water periodically. The Creedy gauge was fixed and is read by men in the employment of the city surveyor.

The rate of passage of floods down the Exe being a matter of interest, the readers of the gauges have been instructed to make hourly observations when a rapid alteration of level is taking place. With the same object in view, a gauge has been erected in the Exe near Dulverton, about 22 miles above Exeter. The gauge was fixed by kind permission of Mr. T. F. Tracy at his Exe Valley Fishery, and is being read daily and hourly when desirable.

The water-supply of Exeter is taken from the Exe between these upper gauges and Exeter quay. The amount taken is known, and will be allowed for. The outflow of these rivers above their confluence, with the amount added, should approximately equal the outflow at Exeter quay.

The observations made so far by Prof. Lewis have shown that the amount of matter carried in suspension by these rivers when in normal condition is extremely small. Half a gallon of water does not yield sufficient material to weigh, and preparations are being made to collect larger quantities. No opportunity has yet arisen of examining the water of a high flood.

During violent floods sand and gravel are rolled along the bottom. No reliable method of determining the amount rolled has ever been devised, but, in the case of the Exe, the committee hope to get a satisfactory estimate by aid of the city surveyor. For some years gravel has been dredged from a reach above Exeter in just sufficient quantity to keep the channel at a constant depth. A record of the amount dredged is promised to the committee.

The areas of the Exe basin above Exeter quay, and of the Creedy, Exe, and Culm basins above the upper gauges, are being measured on the 6-inch maps by Mr. E. F. Elton. This necessitated an examination on the ground of much of the water-parting by Mr. Elton and Mr. Beckit, it having proved to be impossible to determine the parting with sufficient accuracy on any existing map. At the same time computations of the areas above and below certain altitudes, and of the areas occupied by various geological formations, are being made.

The Medway.

The Medway having been canalized, its flow is controlled by sluices and affected by the working of locks. Occasional observations on the water-level or on the current are therefore useless, and attempts are being made to obtain a continuous record of the water-level at two spots about 1½ mile apart. For this purpose two water-level recorders, worked by clocks, have been established, one by permission of Mr. W. E. Martin in his garden in Maidstone, the other by permission of Mr. Randall Mercer in his boathouse near Allington lock. The relative level of the gauges is being determined, and the capacity of all parts of the channel between them will be ascertained as soon as practicable.

The committee is also making arrangements for the collecting and examining of samples of the water in the various conditions of the river. The amount of suspended matter carried by the Medway appears to be far greater than that carried by the Exe, and great importance is attached to the obtaining of reliable data.

The committee desire to express their obligation, not only to the gentlemen named above, but to the Lower Medway Navigation Company. By permission of the chairman, Mr. John Arcoll, the site was prepared for the lower gauge by the staff of the Navigation Company, under the superintendence of Mr. John Rose, their lock-keeper at Allington.

It is to be regretted that considerable irregularities in the clocks have delayed the commencement of a continuous record. Detection of the cause of error necessitated frequent journeys to Maidstone, and in this the committee are now receiving the assistance of Lieut.-General Charles Strahan, R.E.

Other Rivers.

The Severn is a river which it will be desirable to investigate as soon as possible. Some years ago the flow at Worcester was determined with great accuracy during a period of several months by Mr. G. F. Deacon. The committee contemplates the erection of a gauge at Worcester, and periodical examinations of the water under various conditions of current. Mr. Deacon has kindly consented to allow the publication of his results in connection with such observations as may be made by the committee.

It will be desirable, also, to investigate a river which drains a chalk area, such possibly as the Salisbury Avon, with a view to ascertaining the effect of so absorbent a material as chalk on the relation of rainfall to flow-off.

In conclusion, the committee desire to call attention to their urgent need for volunteer observers. Velocity observations should be made as frequently as possible during the rainy seasons. The courses having been measured and staked out, the actual observations are easily and quickly made. Travelling to the spot constitutes the most serious part of the work, but in all cases the courses have been selected as far as possible with a view to their accessibility. In all other branches of the work, also, further assistance is urgently wanted. Rainfall observers in the upper parts of the valleys of all the rivers named could render useful services, and more rainfall observers are required in the case of the Salisbury Avon in particular.

NOTE ON MEASUREMENT OF AREAS IN THE EXE BASIN.

By E. F. ELTON.

The geology of the Exe basin having been put upon the 6-inch map, it was necessary to insert the boundary of the basin. This was generally fixed closely enough by the data of the map; where these data were insufficient I walked over the ground, and thus put upwards of 70 miles of watershed on to the map in the field. In one case the observed line differed from what the map suggested by a plot of some 200 acres; this was exceptional, but the aggregate change was considerable. This suggests that watersheds would be an interesting and useful addition to the Ordnance maps.

The basin requires 133 sheets. These vary much in dimensions. Of the fifty-four measured up to the present, only four have both dimensions correct. The variations range from 0·01 foot of shrinkage to 0·012 foot of stretching. As I am using an Amsler's planimeter with an adjustment for such variations, they do not add materially to the labour.

The measurements are checked as each sheet is finished. The error is in the fourth (rarely the fifth) figure, which, considering the other elements involved, appears to be a satisfactory result; and this error distributes over the various sections of the sheet in proportion to their area.

NOTE ON THE MEASUREMENT OF DISCHARGES OF THE EXE AND MEDWAY RIVERS.

By N. F. MACKENZIE, M. Inst. C.E.

The discharge of any channel is given by the area of its cross-section multiplied by its mean velocity. The area of the section is got by direct measurement, and the problem that presents itself is therefore the determination of the mean velocity. This may be arrived at in various ways, of which the most usual are—

From velocity-rod observations.
From current-meter observations.
From surface velocities.
From the slope of the water-surface.
From velocities at different depths got by sub-surface floats.

The velocity of a floating weighted rod reaching from the surface nearly to the bed is found, by experiment, to be for all practical purposes the mean velocity of the vertical plane in which it moves, and velocity-rods are almost universally used in India for the measurement of canal discharges. Unfortunately, river-beds are, as a rule, too irregular to admit of their use.

Under favourable conditions, the current-meter may be expected to give good results, but the men on whom we have to rely for the observations have had no previous experience in its use; and, apart from this, the time occupied by current-meter observations is far greater than we could expect them to place at our disposal.

It was therefore decided that, whenever possible, the mean velocity should be calculated from observed surface velocities, using a coefficient or reduction multiplier. The coefficient varies with the *rugosity* of the channel, a term which includes all obstructions or irregularities which interfere with the free flow, and it also varies with the hydraulic radius of the channel. The coefficient is therefore not constant even in channels of the same rugosity, nor in the same channel for different gauge-readings.

In selecting a coefficient for reducing surface velocity to a mean velocity, we fortunately have accurate data at our disposal. For many years Indian irrigation engineers have experimented on the relation between surface and mean velocities, and on these experiments are based tables of coefficients which are accepted as correct for all purposes of discharge calculation. Indeed, some irrigation engineers consider that surface-velocity observations give results even more reliable than those obtained from velocity-rods.

The difficulty in the method lies in the proper determination of the rugosity of the channel. This is a matter of expert knowledge, but is comparatively easy for any one who has had experience in this method of measuring discharges.

Measurement of the surface velocity presents no difficulty. The river is divided into longitudinal sections, and floats are run over a measured distance, usually 50 or 100 feet, the time of passage being noted. The mean of several runs is taken for each section, and the length of run divided by the time of passage gives the surface velocity of the section.

Having obtained a series of measured discharges for various gauge-readings,

a discharge-table is drawn up by interpolation, due allowance being made for the variations of the coefficient owing to the altered value of the hydraulic radius. The above is the method adopted for the Exe and its tributaries.

On the Medway, which is canalized, the conditions are different, and a gauge reading gives no indication of the volume of water passing down the river, as navigation depth is maintained by manipulation of the lock-sluices, whatever may be the discharge. It was therefore decided to calculate the discharge from the slope of the water-surface, the slope being got from two gauges at a known distance apart, with their zeros fixed at known levels for comparison. As the conditions governing the surface slope are continually altering, it is necessary that the gauges should be self-recording.

Given the slope of the water-surface, the mean velocity is got from the expression $v = C\sqrt{RI}$, where R is the hydraulic radius, and I is the fall of the water-surface in unit-length. C is a coefficient which varies with the rugosity, surface slope, and hydraulic radius. The equation for C which it is proposed to use is the well-known formula of Kutter, which is based on the experimental investigations of Kutter and Ganguillet—

$$C = \frac{\left(41{\cdot}6 + \frac{1{\cdot}811}{N} + \frac{0{\cdot}00281}{I}\right)\sqrt{R}}{\sqrt{R} + N\left(41{\cdot}6 + \frac{0{\cdot}00281}{I}\right)}$$

where N = Kutter's coefficient of rugosity.

Calculations based on this somewhat formidable expression are much simplified in practice by the use of hydraulic tables, such as those of Higham or of Jackson, in which values of C are worked out for channels of various sizes, slopes, and degrees of rugosity. Intermediate values to suit existing conditions can be obtained by interpolation between the values given in the tables.

As in the case of the Exe, the selection of the proper coefficient of rugosity is the difficult part of the problem. The most satisfactory method will be to measure one or two discharges by the surface-velocity method, and from these calculate the appropriate value of the coefficient, which will then be applied to the surface slopes from the gauge records.

As regards the probable accuracy of the selected methods, it has been found by actual experiment on Indian canals, that surface velocities give discharges varying by not more than half per cent. from those deduced from velocity-rod observations.

The surface-slope method of calculation is more adversely affected by an error in the estimated value of the coefficient of rugosity, but if the appropriate coefficient for the Medway be determined by measurement of surface-velocity discharges, the error is not likely to exceed 1 per cent.

ON THE OBSERVATIONS OF RAINFALL.

By HUGH ROBERT MILL, D.Sc.

The voluntary rainfall observers in all parts of the country furnish data which make it easy to produce small-scale maps showing the monthly or annual rainfall of the British Isles as a whole with considerable accuracy; but when comparatively small areas are dealt with on a large scale, the chance distribution of observers often fails to allow a satisfactory map to be drawn. I have accordingly endeavoured to enlist the services of new observers in the Exe and Medway valleys, so as to fill

up the larger gaps and make it possible to determine the volume of rainfall of any year or month with considerable accuracy, and that of any day with fair accuracy.

There are now at work in the Exe valley or on its margin, sufficiently near the watershed to give useful indications, fifty-four observers of rainfall, most of whom keep daily records. In the Medway valley the representation is equally good, and it was only found necessary to supply rain-gauges from the funds of the committee to six altogether.

The comparison of rainfall with stream-flow will involve considerable difficulty, as the general fall over the whole valley on any one day cannot affect the stream at the point where it is gauged at the same time. It will probably be found necessary to discuss heavy local rains in different parts of the basin in some detail, in order to ascertain how soon the rain finds its way down the stream, and to be guided by the result in carrying on the more general discussion. It is desirable to wait until a considerable number of heavy falls have occurred within the period of the river gaugings before proceeding to make this comparison. At present the accumulation of data is proceeding in a satisfactory way.

OBSERVATIONS OF GLACIER MOVEMENTS IN THE HIMALAYAS.

We quote below, with a few omissions and additions, the Introductory Report furnished by Mr. T. H. Holland, F.R.S., Director of the Geological Survey of India, to the detailed descriptions of the work recently carried out by his officers * in the observation of the movements of Himalayan glaciers.

"In 1905 Mr. D. W. Freshfield, on behalf of the Commission Internationale des Glaciers, drew the attention of Lieut.-Colonel S. G. Burrard, F.R.S., Superintendent of Trigonometrical Surveys, to the importance of recording data for determining the secular movements of the principal Himalayan glaciers. As the work required the co-operation of all officers and private travellers likely to visit the glacier regions of the Himalaya, Colonel Burrard referred the question to the Board of Scientific Advice, and, on the recommendation of a sub-committee composed of Colonel F. B. Longe, R.E., Surveyor-General, Dr. G. T. Walker, F.R.S., and myself, the Board agreed on a system of observations, recommending that the distribution of the necessary information and collection of data should be under the control of the Geological Survey Department. The proposals having received the sanction of the Government of India, the first step in the investigation was taken by the deputation of five Geological Survey officers during August and September, 1906, to make a preliminary survey of the principal glaciers in the Kumaon, Lahaul, and Kashmir regions.

"Altogether twelve glaciers were examined, as follows:—

"*Kashmir Region.*—The Barche and Hinarche glaciers in the Bagrot valley; the Minapin, Hispar, and Yengutsa glaciers in the Nagir State; and the Hassanabad glacier in Hunza. These six were surveyed by Mr. H. H. Hayden.

"*Lahaul.*—The Bara Shigri and Sonapani glaciers were examined by Messrs. H. Walker and E. H. Pascoe.

"*Kumaon.*—The Pindari, Milam, Shan Kulpa, and Poting glaciers were surveyed by Messrs. G. de P. Cotter and J. C. Brown.

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* 'Records of the Geological Survey of India,' vol. 35, parts 3 and 4. 1907. London: Messrs. K. Paul, Trench, & Co.; Calcutta: Geological Survey Office.

"In all cases plane-table sketches were made, showing the exact positions of the ice-caves with reference to points cut and painted on rocks in the valley, as well as with prominent and unmistakable peaks in the vicinity. In some cases cairns were built over the marks, and in the Kashmir area these were placed in charge of the nearest village headmen. The cairn built near the Milam glacier was placed in charge of Bai Bahadur Kishen Singh, who is well known to science as 'A.-K.'

"Photographs were taken from various points of view carefully marked on the map and described in the report, showing the state of the glaciers and the principal masses of moraine material at the time of the visit. These photographs will enable subsequent travellers to form an idea of any changes that may have occurred in the interval, and will thus make their observations of value even if the fixed points cut in the rocks are destroyed by weathering or by being overwhelmed with loose material.

"The short time available rendered it necessary that observations should be confined to one aspect of the glaciers, namely, that of their secular advance or retreat. It was impossible, under the circumstances, to make more than passing observations on such questions as the rate of flow, the lamination of the ice, included dirt bands, and erosive action. These interesting questions must be left for future workers, as it was important in as many instances as possible to fix at once, for the purposes of the main problem, the positions of the snouts and general disposition of the ice with regard to fixed features in the ground around.

"The first point that strikes one on examination of the reports is the fact that the glaciers of the Hunza valley and the Karakoram range generally descend to lower altitudes than in the Lahaul and Kumaon regions. In the former region the snouts of the glaciers proceed down to levels of 7000 or 8000 feet, while in the latter region they melt before descending below the level of about 11,000 feet. [In the Kangchenjunga group the lowest point reached by ice is about 13,000 feet in the great Zemu glacier.] In the Hunza region, also, there are two classes of glaciers—

"(*a*) Those which flow transversely to the trend of the mountain range, and are relatively short, with a steep descent reaching down to elevations as low as 8000 feet and under; and

"(*b*) Those which lie in troughs parallel to the range, and also approximately parallel to the strike of the rocks of which the range is composed. These, having at their angles of slope a less rapid fall, rarely descend below 10,000 feet, and form long glaciers, in some cases making the most magnificent ice-flows in the Himalayas."

The second point prominently displayed is the evidence of general retreat shown by the occurrence in nearly all cases of old moraines (sometimes grass-covered) below the present ice. This point does not, of course, necessarily mean that the glaciers are now in retreat, and two well-authenticated cases of recent advance have been found in the Yengutsa and Hassanabad glaciers, both steep transverse ice-streams. Since 1892, the date of Sir M. Conway's visit, the Yengutsa glacier has advanced at least 2 miles, nor does this advance appear to have been gradual, as, according to local reports, the ice moved forward suddenly some five years ago, and has since remained stationary. The Hassanabad glacier, according to the statement of the Emir of Hunza, also moved forward suddenly some three years ago, covering in two and a half months a distance variously estimated as from 6 miles to one day's march. Owing to the danger involved to the villages near, it was carefully watched, and the above statements may, we are told, be accepted. It is said that the ice occupied its present position many years ago, and subsequently retreated. It is now apparently stationary.

The valleys below the glaciers, being generally covered by moraine material and talus from the hills around, very seldom reveal the solid rock, and consequently the evidence with regard to the erosive action of the ice is insufficient to show whether the glaciers have eroded material in large quantity, or only succeeded in striating and polishing the rocks over which they flowed.

The Reports are illustrated with a large number of plans and photographs. The best thanks of all interested in glacier science are due to Mr. Holland and his staff for the energy with which this important work has been taken up, and the admirable manner in which it has so far been carried out. It is proposed to attack shortly other parts of the Himalaya, including the Kangchenjunga group. It is much to be desired that the example set by the Indian Government may be followed, and that in other parts of the British dominions oversea where glaciers are found, equally systematic observations may be undertaken and carried on by a scientific branch of the local governments.

REVIEWS.

EUROPE.

The Scottish Highlands.

'The Geological Structure of the North-West Highlands of Scotland.' By B. N. Peach, John Horne, W. Gunn, C. T. Clough, and L. Hinxman, with Petrological Chapters and Notes by J. J. H. Teall. Edited by Sir A. Geikie. 1907. Mem. Geol. Surv. Great Britain. Pp. vii. + 668, pl. lii. With coloured geological map on the scale of 4 miles to the inch.

No publication of the British Geological Survey has been so eagerly awaited as the long-promised memoir on the north-western Highlands of Scotland. That country is built of rocks belonging to four groups, which in a traverse from west to east are exposed in the following order: The Lewisian gneiss of the Hebrides and of the western coasts of Sutherland and Ross; the Torridonian, a thick series of sandstones once identified as Old Red Sandstone; a narrow belt, 100 miles in length, of fossiliferous quartzites, shales, and limestones; and, finally on the east, the western edge of the gneisses and schists which form the main bulk of the Scottish Highlands.

The relation of these four rock series to one another has been the most vexed question in British geology. According to Sir Roderick Murchison, the four groups of rocks had been deposited in regular succession, the easternmost being the uppermost and youngest. Nicol, on the other hand, regarded the eastern and western gneisses as belonging to the same series, and the fossiliferous rocks as having been sandwiched between them by earth-movements. According to Nicol the fossiliferous rocks were the youngest, whereas according to Murchison the eastern gneisses were the youngest. Nicol's view was almost unanimously rejected during his lifetime, but shortly after his death a paper by Prof. Bonney proved that some, at least, of the eastern rocks were the old Lewisian rocks upraised by earth-movements. In 1882–3 the truth of the essential part of Nicol's theory was further demonstrated by Prof. Lapworth's detailed survey of some sections beside Loch Eriboll. He explained how the old eastern gneisses came to be above the younger fosiliferous rocks, as he found that the gneiss had been forced westward, riding over the crumpled masses of the younger beds. Murchison's theory was finally abandoned in 1884, when the results of the first season's work of the Geological Survey in this area were announced by Sir Archibald Geikie. The Geological Survey has now

completed the detailed mapping of the area, and has published maps of two of the most critical localities on the scale of 6 inches to the mile. The work has proved conclusively that the perplexing features in the geology of the area are due to a series of overthrusts. Nicol was therefore right as to the relative ages of the rocks but Murchison was right in the secondary point that the eastern and western gneisses are distinct series. The Survey has shown that the earth-movements are on a very extensive scale; they can be traced from the shore of the Pentland frith for 100 miles southward to the Sleat of Skye, and they have in some places carried the older rocks 10 miles westward over the younger. The conclusions of the Survey were announced in *Nature* by Sir Archibald Geikie in 1884, and a preliminary account of the evidence was published by the Geological Society in 1888; but it has taken another nineteen years for the collection of the complete detailed evidence and its arrangement for publication. It has now been issued in the best illustrated, the cheapest, and probably the most important memoir ever issued by the British Geological Survey. The work gives a full technical description of the geology of this area, but the details are necessary in order to understand the extreme complexity of its tectonic structure.

The book has been written by the surveyors, with the exception of the petrological chapters by Dr. Teall. Dr. Horne, the director of the Geological Survey of Scotland, is the largest contributor to the volume, and his series of introductory chapters lucidly explains both the problems and the general results. The volume has been edited by Sir Archibald Geikie, who initiated the work in 1883, and superintended it till his retirement in 1901, and the text has no doubt benefited greatly by his careful literary revision.

The part of the work of most geographical interest is that dealing with the earth-movements, which are of a type first recognized and described in north-western Scotland, and which have been more thoroughly investigated there than elsewhere. The over-riding of the eastern rocks is illustrated by the elaborate, but clear sections drawn by Mr. Peach. In the most complex part of the area, around Loch Assynt, there are three main thrust-planes, named the Glen Coul, Ben More, and Moine thrust-planes. The evidence for the existence of these three planes of movement, their effect both on the rock masses, and on the rocks beside them, the complex series of minor faults which they occasioned, and the intense changes in the rocks along the planes of movement, are fully described, and illustrated by instructive photographs.

Doubts are still sometimes expressed as to the truth of the overthrust theory, but they are no longer excusable, after the convincing detail of this most important memoir.

J. W. G.

ASIA.

Borderlands of the Indian Empire.

'The Marches of Hindustan: the Record of a Journey in Thibet, Trans-Himalayan India, Chinese Turkestan, Russian Turkestan, and Persia.' By David Fraser. Edinburgh and London: Blackwood & Sons. 1907. *Map and Illustrations. Price* 21*s. net.*

Within the covers of this volume, which extends considerably over five hundred pages, materials for three separate books will be found. First, geographical; the traveller's diary kept with the eye and pen of a trained correspondent of newspapers; scenes, scenery, hardships, pleasures, all set forth with much accuracy and no little humour: next, historical and archæological; for the most part transcription or condensation of what has been published elsewhere, but useful to readers who

know little or nothing of the countries visited: and last, but by far the most important, political and economic. The conflicting interests of England and Russia are examined with shrewdness and impartiality, whilst the possibilities of trade, its development and protection, are considered; and there are remarks about Persia, her resources and proposed railways, which at this moment of apparent trouble, if not revolution, in that land, have a special value and significance.

Seven chapters are devoted to Tibet. They contain an admirable description of the journey from Calcutta by Darjiling and Sikkim to Gantok, Chumbi, and Phari, where the Tashi Lama was met on his return from India. Mr. Fraser wired to the Foreign Office at Calcutta for permission to accompany him and his party to Shigatse, and, this being granted, the country was seen under unusually favourable circumstances. For as the people had dreaded the Indian visit of their beloved Lama, and had mourned for him as dead, so now on seeing him again they rejoiced exceedingly, and thronged to Shigatse to receive his blessing and the protection thus afforded against the spirits of evil. The ceremonies, which are well described, were wound up by a discussion between two monks, one representing Satan, and the other some sacred person.

The return journey was made through a very rough and little-known country, partly west, but mainly south, from Shigatse, skirting Kanchenjanga and among the loftiest peaks in the neighbourhood. The experience gained made Mr. Fraser anxious to see more of the Indian frontiers, so he went to Simla and got permission to cross into Central Asia, whilst, by arrangement with the Chinese Government, he was permitted to visit Chinese Turkistan, respecting which, including the desert of Takla Makan and its sand-buried ruins, so much has recently been written in our *Journal*.

The route followed was by Kúlu, that most attractive valley, through Láhaul and Zanskar, by Leh and the Karakoram pass to Khotan, Yarkand, and Kashgar. Thence Mr. Fraser travelled west by the Terek pass to Kokand, Tashkend, Bokhara, Merv, Mashhad, Teheran, and Baku, where his journey so far as this book is concerned may be said to end. He left Calcutta in January, 1906, and reached London towards the end of January, 1907, so that his interesting adventure lasted a little more than a year.

The historical and archæological parts of the volume need not be closely examined in this notice, whilst political and economic considerations are not usually permitted great prominence in the treatment of matters geographical. Yet they are of all others the most vital, and in this book remarks and deductions respecting the interests of our empire and those of other nations will be found recorded. They are deserving of deep attention, as a glance at the matters touched on will show. For they include such great questions as the defence of India in its most extensive signification from outer attack by arms, or from a more insidious, though to the enemy less dangerous, assault on its trade.

The importance of our exercising permanent influence in Tibet is well set forth. Not merely are the great ranges of the Himalaya our rampart, but Tibet itself, sloping from them to the deserts, is the glacis of our fortification, and a better one could scarcely be conceived. But apart from outside attack, there is the strong sympathy of such states as Nepal, Bhutan, and Sikkim with Tibet, resulting from community of religion, a sympathy which might easily be utilized to our detriment if another nation were supreme in that country. To prevent this, the recent mission under Sir F. Younghusband was undertaken and brought to a successful issue without estranging the goodwill of the great majority of the people and their rulers, only to have nearly every point gained sacrificed.

Again, the effect of railway construction by Russia in Central Asia, on the

north-western frontier of India, is considered. Then as regards Persia, the railway question is examined, and an opinion adverse to construction is expressed. German intervention and the general activity of that enterprising race are not forgotten. These matters are important when attempting to place a just value on the recent Anglo-Russian understanding.

The volume is profusely illustrated, and is well turned out. Misprints are few; among them (p. 252) is the substitution of Bedaulat (unfortunate) for Badaulat (fortunate). There is a map, which serves its purpose, though it cannot be said to contribute much to recent geographical record.

W. Broadfoot.

Indian Frontier Life.

'Twenty Years on the Indian North-West Frontier.' By G. B. Scott (Survey of India). Allahabad: Pioneer Press. 1906.

Few civilians indeed could lay claim to have taken conspicuous part in so much rough-and-tumble fighting as Mr. G. B. Scott. As a qualified and trained surveyor, possessed of scientific acquirements, he joined the Survey of India Department over forty years ago. He was told off to take his share in the work of the Umbela Campaign in 1863, and since then his capacity for trans-frontier surveying has led to his being attached to most of the military expeditions despatched against the border tribesmen, as well as to his serving in the regular campaigns in Afghanistan in 1878–80. Altogether Mr. Scott must have amassed material enough for a serious work of really exceptional interest. The present book is of modest dimensions, but places on record a number of interesting incidents and episodes connected with the expeditions described. Once the author, hearing firing towards sundown, discovered several tribesmen lining the opposite banks of a stream and firing across at each other. A dispute had arisen as to whether the new moon had been seen or not on the previous evening, which marked the close of the Ramazan fast. Angry words and shots ensued, and eight men were killed and wounded before the point was settled. On another occasion we are told how a bottle of chlorodyne had broken in transit and soaked into the Christmas pudding of a regimental mess. However, an overwhelming vote decided that the pudding should be eaten, which was accordingly done—happily with no disastrous consequences.

With characteristic modesty, Mr. Scott has said nothing about exploits of his own in 1868 and 1878. For the first named he was granted a sword of honour by the Punjab Government; on the second occasion he fought for the whole afternoon against a lot of Mohmauds who attacked him and his party near Fort Michni. Through Mr. Scott's gallantry the tribesmen were beaten off and the little detachment saved. We hope that the success of the present little work may tempt the author to furnish a more exhaustive treatise on the Indian frontier events of the past fifty years—a subject which he is well qualified to handle with knowledge and authority.

Western Tibet.

'A History of Western Tibet: one of the Unknown Empires.' By Rev. A. H. Francke, Moravian Missionary. London: S. W. Partridge & Co. *Maps and Illustrations. Price* 2*s* 6*d. net.*

This excellent little work has a preface by Mr. Thomas, librarian at the India Office, in which he says, "The English reader may repose every confidence in this interestingly written *History of Western Tibet*, as the outcome, not only of scholarly enterprise and research, but also of familiarity with the country and the people." That is high praise, and so far as we can judge it is deserved. Much information is

collected, gathered from the writings of Megasthenes and Herodotus, from inscriptions and sculptures on rocks, and from local records of those early times to the days when that country ceased to be an independent state, and became, as it still is, part of Kashmir and Jammu. As is fitting, the interest of the book is historical rather than geographical; indeed, from the latter point of view it is defective so far that the vague expression "Western Tibet" is not defined. Probably Ladákh is generally meant, but its boundaries extended into Tibet proper on the east, and included Spiti and Lahaul, if not also Kulu, on the west, all three being now subdivisions of the Kangra district of the Punjab. The two first were undoubtedly Tibetan, whilst Kulu is a Rajput state, inhabited chiefly by Hindus; all these were visited by the pilgrim Hiuen Tsang in the seventh century.

Mr. Francke's researches in folklore are evident in the verses he appends to each chapter; some are very quaint, as is the song of a Mon musician to his fiddle, called "Trashi wanggyal"; others are pretty, as that of the maiden tending flocks to a youth across the valley; and one, at any rate, may be called geographical in that it describes the origin of the world.

"How did the Earth first grow?
At first the Earth grew on a lake.
What grew on the water?
On the water grew a meadow.
What grew on the meadow?
Three hills grew there."

And so on till life is developed.

W. Broadfoot.

AFRICA.

Across Africa from East to West.

'Across Widest Africa.' An account of the country and people of Eastern, Central and Western Africa, as seen during a twelve months' journey from Djibuti to Cape Verde. By A. Henry Savage Landor. Illustrated by 160 half-tone reproductions of photographs and a map of the route. Two vols. London: Hurst & Blackett, Ltd. 1907. *Price* 42*s. net.*

Mr. Savage Landor spent the year 1906 in a journey across Africa from Jibuti to Cape Verde. He travelled rapidly, and, with unimportant exceptions, followed routes already known. Nevertheless, his book has a certain amount of information of value to the cartographer. For instance, on several occasions the author found that the sites of native towns in the Ubangi region had been shifted since the time of the Marchand expedition. It is only, however, with respect to the Lake Chad region that any attempt is made to deal in detail with geographical problems. Mr. Landor crossed the south-eastern part of the lake in a small steamboat, and for about a fortnight skirted its eastern and northern shores—traversing part of the dry bed of the lake. He gives a sketch-map and chart "from latest surveys by French officers and A. Henry Landor," but it is evident that his information is based mainly on the recent labours of French officers. He makes no mention of the prolonged and careful surveys by Lieut. Boyd Alexander and Mr. P. A. Talbot, but observes that "of late years a few French and German travellers have done magnificent work in that region. Among them may be mentioned Barth, Overweg, Nachtigal, Colonel Monteil, Messieurs Foureau-Lamy," etc. Mr. Landor is better informed when dealing with the countries of the middle Niger and Senegal, having received from the French authorities many details illustrative of the astonishing economic development of their West African colonies.

The author appears to be more interested in ethnography than in any of the other subjects that appeal to African travellers—except, indeed, in his own celerity of movement. His scorn of quinine, his belief that to roast one's self in the tropical sun is the best way to ensure health, his touching faith in castor-oil as an almost infallible cure for all ailments—in short (as is very natural) his achievements and his manner of life in equatorial regions bulk largely in these two portly volumes. But next in interest come the peoples he met, some of whom he had opportunities of studying for three or four weeks, some for a few hours only. But of all alike he has much to say.

When Mr. Landor confines himself to describing what came under his personal observation he is well worth attention. His spelling of place-names is generally in the bad French fashion; his photographs are generally good. The map showing his route, on the scale of 1 : 10,000,000, is extracted from that of the Geographical Society of Paris. The index is faulty, and there is no summary of the contents of the chapters. One merit the books certainly have—they are light to handle.

F. R. C.

THE SOUTH-WESTERN PART OF THE CONGO FREE STATE.

'Im Schatten des Kongostaates.' By Dr. Leo Frobenius. Berlin: Georg Reimer. 1907. *Price* 14*m*.

Dr. Leo Frobenius, chief of the German exploring expedition of inner Africa, travelled up the Kasai, the Kwilu, the Lulua, Sankuru, and upper Lomami rivers between the years 1904 and 1906. His work has been expected with considerable interest in ethnological circles; it was known that he had made considerable collections to illustrate the culture of the Bakuba and Baluba peoples, and it was hoped, amongst other things, that he would give us some positive knowledge of the little-known Bakuba speech, the classification of which is still a great puzzle to students of Congoland.

It must, I fear, be admitted that the book under review is somewhat of a disappointment.

In the first place, the publishers have gone far to spoil its chances of success in English circles by reverting to the intolerable German type, instead of using Roman letters. The reviewer has had occasion of late to read a great many German books dealing with Africa, more especially African languages, or to subscribe to German reviews of the same purport, and has become so used to all this excellent scientific material being presented in Roman type that he feels indignant any man of science of the standing of Dr. Frobenius should have allowed his important study of South-West Congoland to be printed in the old-fashioned German type. German at its best is not an easy language to read, but it is fifty times more difficult when written or printed in the old black-letter characters.

Except for this fault of type, *and the absence of an index*, the book is well got up. Many of the photographs are admirable. As to the drawings and the black-and-white reproductions of paintings by Herr Lemme, one's feelings are rather divided. Some of these studies are beautiful works of art, such as the two drawings on pp. 57 and 59 of pineapples growing wild. But they and similar studies are quite unnecessary from a scientific point of view, as the pineapple is not a native of Africa. Some of the sketches of river and other landscapes are clever, but not particularly faithful to actuality, or convincing to those who know anything about Central Africa. For instance, in a sketch supposed to illustrate the Congo at Boma, the artist inserts two Giant cranes of a purely South African species, entirely foreign to the Congo region. Other of Herr Lemme's drawings of trees remind one of studies by Leader, but they might just as well be magnificent clumps of Scotch

pines as any African tree, just as his rough sketches of natives resemble rapid studies from the nude of Italian old masters rather than characteristic portraits of negroes. Some of his drawings, however, of the parasitic fig-trees are not only beautiful studies, but very accurate. The comic pictures, however, whether by Herr Lemme or anybody else, on pp. 289 and 295, are quite out of place in a work of serious pretensions. With all these criticisms, however, the general effect of Herr Lemme's drawings is very striking, and certainly helps the untravelled reader to get a general idea of Congo scenery. There is an admirable study of elephants opposite p. 412.

In the beginning of the book, Frobenius gives some remarkable photographs of early Portuguese inscriptions on the rock-surfaces of Matadi, which were certainly not previously known to the writer of this review. He does not, however, in his text explain exactly where these inscriptions were situated, or what deductions there are as to their history and age. As his book is—*mirabile dictu!*—without an index, it is possible that the reviewer has overlooked the references in the text to these old Portuguese inscriptions. The photographs are clear and interesting, and the matter should certainly be studied in connection with the history of the Congo. Apparently the inscriptions were discovered by a Swedish missionary named Domenjoz.

The author contributes interesting information regarding that mysterious people the Bakuba, but does not throw any light on their peculiar Bantu dialect. The Bakuba, like some of the Baluba and the Bakioko, are obviously tinged with ancient Hamitic blood, no doubt from the same sources as the Hamitic aristocracies of western Uganda and north-western German East Africa. Some studies of Kioko women's faces by Herr Lemme are singularly Egyptian in appearance. Dr. Frobenius contributes much new information about the imperious raiding Kioko or Kioke people of Luba Land. There is a photograph on p. 347 (to which I can find no reference in the text) showing that the sleeping sickness has extended far into the basin of the Kasai and the Lulua. There is also much information, well illustrated, as to the different types of native houses, and there are notes and illustrations concerning breeds of the domestic goat and dog which are of importance. The maps in the text are almost innumerable, and some are of great interest from the remarks on the rocks and geological formation of south-west Congoland.

The book is one which should be firstly reprinted in the Roman character, and secondly translated into English. But the English edition must emphatically be provided with an index. In such a rendering the spelling of the native names should be revised. Dr. Frobenius' orthography is worthy of the middle nineteenth century in its unnecessary doubled consonants, its *tsch*'s and *dsch*'s. For instance, Boma, the capital of the Congo Independent State, is persistently spelt "Bomma." Why? The native pronunciation is Mboma, and the European rendering Boma—both rhyming with Roma. Why, then, spell it "Bomma"?

H. H. Johnston.

AMERICA.

Newfoundland.

'Newfoundland and its Untrodden Ways.' By J. G. Millais, F.Z.S. *With Illustrations by the author.* Longmans, Green, & Co. *Price* 21*s. net.*

Mr. Millais has made four visits to England's oldest colony, and of those visits this book is the outcome. The author describes his volume as a "hunter's book," and it is safe to say that no one who has made or who contemplates a journey in Newfoundland after woodland caribou will disagree with that definition.

Of the four separate trips which together make up Mr. Millais' knowledge of

Newfoundland, the two most important were those last undertaken and commenced from the south coast, for they led him through a country that to a great extent is patrolled only by the Micmac Indians, whose hunting-ground it forms. The credit of the original inception of the idea of following the caribou into the centre of the island, instead of shooting them as they cross the railway line upon their autumn migration, belongs to Mr. F. C. Selous, who in 1900 went in from Terra Nova and packed from the head of George's pond to John's pond. Mr. Selous' book, 'Recent Hunting Trips in North America,' in which *inter alia* he describes the incidents of his travels in Newfoundland, is probably the most valuable contribution to the literature of big-game shooting published in recent years; but whereas Mr. Selous' work deals almost exclusively with his experiences after caribou, that of Mr. Millais is of larger scope, and includes an exceedingly interesting chapter upon the Micmac Indians (some of whom accompanied him upon his two south coast journeys), as well as a chapter upon the island whale fishery.

There can be little doubt in the mind of the reader that during the author's first trip in Newfoundland, the fascination of the island laid its spell upon him. Realizing how comparatively little was known of the interior, he in subsequent journeys travelled up the Gander river, crossed the island from the south coast to the line at Glenwood, and finally penetrated the country in the neighbourhood of Mount Silvester. These journeys, of which accounts have already appeared in the *Journal*, were performed mostly in canoes, by means of which it is possible to travel very extensively through the waterways of linked lakes and streams. But some long portages were necessary, especially near the headwaters of the Gander.

The narrative in which the author describes his wanderings is always interesting, more particularly the parts of it which tell of his deer-stalking experiences, both in the thick timber and upon ground as open as that of a Scottish deer-forest.

But the most valuable chapters in the book are those in which Mr. Millais deals with the habits and natural history of the caribou. Both by natural tastes and by preparation Mr. Millais is a field naturalist of great attainments, and his observations are always interesting. These facts, added to his skill in illustration, give him a place apart from any of his contemporaries. The illustrations are indeed admirable, and the author shows much ingenuity in avoiding too many representations of caribou; if indeed it is possible to have too many sketches such as grace pages 80 and 81.

H. P.

An Abortive Enterprise in Brazil.

Recollections of an Ill-fated Expedition to the Headwaters of the Madeira River in Brazil.' By Neville B. Craig, in co-operation with the members of the Madeira and Mamoré Association of Philadelphia. Philadelphia and London: J. B. Lippincott Company. 1907. *Price* 18*s. net.*

The failure of the attempt to build a railway from Santo Antonio, at the foot of the Madeira cataracts, to the navigable waters of the Beni and Mamore has always been a source of deep regret to those who have at heart the development of the great resources of Central South America.

It was in October, 1877, that Messrs. P. & T. Collins obtained from Colonel Church the contract to construct the railway, and on January 2 ensuing the *Mercedita* sailed from Philadelphia with the first contingent for the field of action, from which previous workers had been driven by the ever-present malaria fever. It is this enterprise that forms the subject of Mr. Craig's chronicle, a record of admirable courage and perseverance, combined with a light-hearted indifference about the most obvious precautions, that contributed in no small degree to the

misfortunes which followed in quick succession. The wholly unnecessary discomforts of the voyage of the *Mercedita*, so amusingly described by the author, are typical of all the troubles that came afterwards. There can be little doubt, however, that, had funds been available, the railway would have been built in spite of every obstacle.

The couple of hundred miles of the Rio Madeira that form the background of the story have an evil reputation, which is difficult to realize on the spot as the wonderful panorama of smooth, broad river and luxuriant forest, with intervening tracts of rocks and tumbling waters, passes before one's eyes. Much of the illness has always been of a preventable character, and with our present knowledge of malaria and the methods of dealing with it there should be no difficulty in constructing the line, which, under a contract with the Brazilian Government, has now been once more commenced.

Mr. Craig has some difficulty in understanding how malaria can exist in a region where there are usually no human inhabitants to act as intermediate hosts to the germs. The difficulty disappears if the local belief that monkeys suffer from the disease be well founded, and it is possible that other animals are also susceptible.

When in 1879 the courts decided that the enterprise must be abandoned, the workmen, already weakened by disease, were left destitute of funds and resources, far from civilization, in the heart of the continent, and in their pitiful efforts to return home still further additions were made to the long death-roll of the expedition. Ultimately those who remained were brought home by the contractors.

Out of 719 persons, mainly Americans and Italians, who arrived at Santo Antonio, some 140 are known to have lost their lives, and this does not include all of those who died on their way back, or the eighty who were drowned in the ill-fated *Metropolis* on their outward journey. One would have liked to have heard more of the seventy-five who perished in an attempt to reach Bolivia overland; what route they took, and how they met their death.

The book is well illustrated with photographs and maps.

J. W. Evans.

Lakes Poopo and Titicaca.

'Les Lacs des hauts Plateaux de l'Amerique du Sud.' By Dr. M. Neveu-Lemaire. Paris: Imprimerie Nationale, Librairie H. Le Soudier. 1906. *Price* 7 *fr.* 50.

The author was one of the *personnel* of the "Mission francaise" that recently carried out a topographical and geological survey of a portion of Bolivia. He spent the greater parts of the months of June, July, and August, 1903, in the study of the two great lakes of the Bolivian tableland. The specimens collected were subsequently examined in Paris.

Little attention had previously been paid to Lake Poopo, though it presents features of great interest. It is extremely shallow, for, though it has a length of 55 miles and a breadth of 25 miles, only a small portion is more than 4 feet deep, and 13 feet was the greatest depth observed. It is, therefore, a mere film of water covering the lower portion of the plain. It has no outlet, and its level is slowly sinking, so that it may, at no distant date, resemble the South Bolivian lakes that only exist as such in the rainy season. The water contains 2·35 per cent. of solid matter in solution, about two-thirds of that in sea-water. Of this 1·68 per cent consists of sodium chloride, and the remainder mainly of sulphates.

Lake Titicaca is in many ways a complete contrast. The greatest depth observed was 892 feet, and a considerable portion of its basin lies at a lower level than that of Lake Poopo, into which its waters overflow, and whose surface is 400

feet lower. As a result of this outflow the water is comparatively fresh, containing only 0·11 per cent. of solid matter in solution. The salts from the catchment areas of both lakes are therefore accumulating in the basin that lies at the greater height. An interesting feature is the uniform temperature below the surface, almost exactly 11° C. at the time when the observations were made. Alexander Agassiz, on the other hand, who made similar observations in the summer, found a rather higher temperature to prevail—about 12°·5 C.

The sediment dredged from the centre of the lake contained 17 per cent. of organic material, 78 per cent. of inorganic mud almost free from lime, and 5 per cent. of sand. On the other hand, near Chililaya, in the small area separated from the remainder of the lake by the Straits of Tiquina, there was 59 per cent. of calcareous, and 13 per cent. of non-calcareous mud, 12 per cent. of organic matter, and 16 per cent. of sand. Under the microscope small coal-like grains, sponge spicules, diatoms, and material of volcanic origin were observed. Near the north-east shore, in the neighbourhood of Huaicho, the lake-bottom consists of fine sand, including rounded quartz grains closely similar to those of the Sahara.

The transparency of the water in the centre of the lake was found to be practically the same as that of the Lake of Geneva, while, curiously enough, in the small Chililaya basin it was considerably greater.

It is probable that the lakes were once united, forming a narrow inland sea of considerable area, at a somewhat higher level than that of Lake Titicaca. There is, however, no evidence that its waters ever flowed outwards, as the author suggests, by the way of the Rio de La Paz to the basin of the Amazon.

The fish obtained from the lakes were determined by Dr. Jacques Pellegrin. They belong to two genera—Orestias (*Cyprinodontidæ*), peculiar to the Andes, but closely allied to Empetrichthys of the desert of Amargosa, on the borders of California and Nevada, and Trichomycterus (*Siluridæ*), a Southern American genus found both at high and low levels. They include a new species, *O. Neveui*, Pellegrin. One fish only is found in Lake Poopo, and this is believed to be identical with *Orestias Agassizi*, C. & V., var. *inornata*, Pellegrin, of Lake Titicaca.

The author has himself described the fish parasites, while the molluscs are dealt with by Monsieur A. Bavay. The latter include a species, *Paludestrina poopoensis*, Bavay, peculiar to Lake Poopo, and *Ancylus Crequi*, Bavay, which does not resemble any previously described South American species. The crustacea, some of which are new, were determined by Monsieur Ed. Chevreux, Dr. Edward A. Birge, and Dr. C. Dwight March. One species of Copepoda, *Boeckella poopoensis*, Dwight Marsh, is only found in Lake Poopo; another, *B. occidentalis*, Dwight Marsh, is common to the two lakes.

The book is well illustrated by maps, drawings in black and white and colours, and reproductions from photographs.

In conclusion, it may be noted that there are numerous smaller lakes in the high tablelands of the Andean tract, which are of considerable interest, but are not dealt with in the present paper.

J. W. Evans.

The Argentine Republic.

'Modern Argentina. . . . with Notes on Uruguay and Chile.' By W. H. Koebel. London: F. Griffiths. 1907. Pp. xvi. and 380. *Illustrations. Price* 12*s. 6d. net.*

When a man attempts to portray the social, economical, commercial, and political conditions of a country so advanced in the scale of the world's nationalities as Argentina in the space of one comparatively small volume (which also includes references to similar conditions in Chile and Uruguay), his work must necessarily

be superficial. The social and political side of Argentine life, the description of Buenos Aires, and general criticisms on the relations between the Englishman and the Argentine in that city, hardly supply anything new for the consideration of the reader, although the author does well to emphasize those facts connected with the gradual evolution of the Argentine nation which are of special interest in days when the integrity of older nationalities seems to be seriously imperilled by a slackness in expressions of loyalty to the flag. He points out that the Britisher in Argentina soon ceases to be British under the influence of a constant environment of fervid patriotic feeling, and that this feeling is the real secret of the extraordinary success of that country in absorbing and assimilating other nationalities to its own. The Englishman's pride of race and country disappears in one generation, if not sooner, and he becomes essentially as much an Argentine unit in heart and soul as any Spanish or Italian colonist in the land; in spite of the fact that the Government of the country admits of no foreign influence and is absolutely Argentine. This is, after all, chiefly the result of a wise supervision of educational methods, which insists on the constant recognition of the virtue of patriotism and the duties of citizenship as an integral part of each day's instruction in school. It is the same in Chile. It is in this way that nations are framed and consolidated, and it is the apathetic neglect of such principles that disintegrates a nationality.

The best chapters in the book are those which deal with camp and estancia life. This is the soul of Argentina, and it is well to know how the foundations of fortune are laid by the penniless immigrant who, in the process of building up his own fortune, adds his quota to the wealth and strength of the country of his adoption. The extraordinary development of agriculture is very rightly attributed to the results of Italian colonist labour. In the neighbouring state of Uruguay there are no Italian colonists, and the industries of the country are entirely pastoral. In Argentina, beyond a Boer colony and a colony of very mixed nationality, there are none but Italian settlers, and their success in the field of agriculture has certainly influenced the Gaucho, who not so long ago would never have dreamed of putting his hand to the plough. Argentina could easily absorb ten times the present strength of her agricultural population, and in many ways opens a more attractive field than Canada. It is to prospective emigrants that this book should be specially valuable.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Supan's Physical Geography.

'Grundzüge der Physischen Erdkunde.' Alexander Supan. Leipzig: 1908. Pp. 936, xx. pl., 252 figs.

Geography and all geographers are deeply indebted to Dr. Alexander Supan for his editorship of *Petermanns Mitteilungen*; and he has added to that debt by the preparation of his 'Grundzüge,' one of the most complete and up-to-date manuals of physical geography. It is only five years since the issue of the third edition, but a fourth now appears revised and enlarged. It is accompanied by a physical atlas of twenty small coloured maps of the world, which illustrate the chief factors that control climate, the distribution of animals and plants, the distribution of earthquakes, of volcanoes, and movements of elevation and depression, the larger geographical homologies, and the arrangement of the chief terrestrial features. Much new information has been added to the section on biogeography which is of growing importance in geography, as the study of the distribution of extinct animals in such works as those of Lydekker has thrown such valuable light on the former arrangement of land and water on the globe.

The book is divided into six main sections: the first deals with the Earth as a whole and the chief modifications of its surface; the remaining sections deal respectively with the atmosphere, the oceans, the dynamics of the land, the surface of the land, and with biogeography. The work therefore covers the whole range of what is usually included in physical geography, except that there is no account of the races of mankind, and no special topographical descriptions of the physical structure of each continent. The latter omission is no doubt due to the fact that the work deals with the general principles of the science, and not with their local application.

As a text-book of physical geography it is of the highest value, from its completeness, its accuracy, the author's wide acquaintance with recent literature, and his fair and cautious judgments. Each chapter is followed by a list of references which forms a bibliography of recent literature on the subject. These valuable lists would be even more useful if the titles were printed on separate lines instead of in continuous paragraphs.

It is impossible to summarize the contents of such a condensed summary as this work. As an instance of its completeness, reference may be made to the details of borings in coral reefs later than that at Funafuti, and their further proof of the complex and variable nature of the rocks, in the limestone sheets of coral islands. The author accepts the fact that the Funafuti boring proved the existence of coral reefs now more than 1000 feet below sea-level, and also the inference that they there proved the subsidence of that island; but he concludes that there is no one theory of coral islands of general validity. The author expresses his regret that the term "Gulf Stream" has not been abandoned, and gives an interesting summary of recent work on the circulation of the North Atlantic, though here may be remarked an exception from the usual completeness of the geographical references in the omission of note of Mr. H. N. Dickson's important contributions to that subject.

J. W. G.

American Physical Geography.

'Physiography.' R. D. Salisbury. London: 1907. Pp. 770, xxvi. pl., 707 figs. *Price* 21*s. net.*

The term "physiography" has been very differently used. One classic German text-book adopts it for the description of rocks and minerals; in this country it is usual to accept it, as proposed by Huxley, for a preliminary elementary introduction to natural science. According to Prof. R. D. Salisbury, "physiography has to do primarily with the surface of the lithosphere, and with the relations of air and water to it. Its field is the zone of contact of air and water with land, and of air with water." Upon this definition, which is popular in America, physiography is synonymous with physical geography, and it is not clear what advantage is gained by the use of the special term. This work may, therefore, be regarded as an advanced text-book of physical geography, for which, in English, there has long been an opening; and it will be warmly welcomed, as it is written by a geologist who has given special attention to physical problems, and is at the same time an experienced author and teacher. The work is a sequel to Prof. Chamberlin and Salisbury's text-book of Geology, to which it serves as a fourth volume.

The structural and geological parts of the subject are the most fully treated, there being a full account of the earth-forms, and of the physical agents which mould them. The work of the atmosphere, of ground-water, of running water, of snow and ice, shore action, volcanic phenomena, and crustal movements, are treated in successive chapters. After a full sketch of the structure and

modifications of the lithosphere, there follow chapters devoted to the work of the atmosphere, and of the ocean in so far as they affect the lithosphere. Each chapter is followed by a statement of exercises, and by references, which naturally are taken mainly from the literature of the United States. The work is magnificently illustrated, and shows the tendency to make more and more use of illustrations in text-books; it consists, including index, of 770 pp., and as it contains 707 figures, many of which occupy a full page, and it has 26 plates, a large proportion of the work is occupied by the figures. The text is accordingly often less detailed than would be at first expected in so large a volume.

Apart from its value as a text-book, it will be of great service from its collection of the leading illustrations supplied by the United States of the phenomena of physical geography. It makes many references to Europe, but its most detailed and instructive information is American. Some of the instances quoted from other countries are sometimes more interesting than precise, such as the statement of fogs costing London one million and three-quarter dollars a day.

The work includes useful descriptions of many incidents of geographical interest that have happened in the United States, such as the earthquakes of Charleston and San Francisco, the storms which devasted Galveston and Louisville, and the uptilting of the area near the Great Lakes. The author deals with many disputed problems, and his opinions will be read with interest. He holds that variations in the amount of carbonic acid in the atmosphere have been the cause of former glaciations, and that fiords are the result of glacial erosion; he accepts Sir John Murray's theory of coral islands, and the limitation of the Gulf Stream to the west of Newfoundland. He appears to set little value on Brückner's thirty-five year weather periods, and does not regard the plasticity of ice as an adequate explanation of the flow of glaciers. We note that the author does not use the word "corrosion" as distinguished from "erosion," a useful difference which we have learnt from America, and which has gained ground steadily in this country, though during recent years it has been to a large extent abandoned in America. Whether we agree with the author or not upon his conclusions on disputed questions, we can always admire the fair and cautious judgments in this valuable comprehensive text-book.

J. W. G.

The Weather at Sea.

'Notes on Maritime Meteorology.' By M. W. Campbell Hepworth. London: G. Philip & Son. 1907. *Charts and Diagrams. Price* 2*s.* 6*d. net.*

In this useful little volume, Captain Campbell Hepworth has brought together his various papers on marine meteorology. They comprise—Meteorology, a Factor in Naval Warfare; Meteorological Observations at Sea; Weather off South Africa and on the Route from the Cape to Australia, about Australasia, and across the Pacific from Fiji to Hawaii. These papers give evidence of much steady work and careful observation. They cannot fail to be of help and interest to all concerned in the science of meteorology.

It has been abundantly proved that weather is a matter of the greatest importance in naval warfare. We believe that naval officers are fully aware of this fact, and that they give more thought and study to weather conditions than Captain Campbell Hepworth seems to think. At the same time, a perusal of these papers would undoubtedly be of service to all sailors.

Our present knowledge of meteorological laws is so limited, that no methods or

rules for forecasting weather can be advocated as absolutely reliable. Experience shows, unfortunately, that the very best methods are sometimes at fault.

Nine years previous to Captain Campbell Hepworth's paper, we dealt with the storm system on the route between the Cape and Australia; our conclusions, based on the examination of numerous observations taken personally in different sailing ships, were that no one route is better or more reliable than another. The belt of storms shifts up and down in a way not yet understood, although it would appear that the chief controlling influences are the changing barometric areas in Central Asia and the variations of pressure at the south pole. A ship may run the easterly course in 40° one voyage, and have a fine "slant;" in the same parallel, on another voyage, the conditions may be most unsatisfactory.

It is a pity that more sailors do not follow Captain Campbell Hepworth's example, and record their meteorological observations at sea. By so doing they might render incalculable service to a science that has many baffling problems.

D. W. B.

SHORT NOTICES.

Europe.—'Through Great Britain and Ireland with Cromwell.' By H. E. Marshall. (London: Jack (*n.d.*). Pp. ix., 141. *Maps and Illustrations.*) This, the first of a series of similar works, is an attractive book for school children. It is not laid down exactly on the lines of historical geography as generally understood, but is rather a combination of history and geographical description. Cromwell's career is detailed, and wherever an important geographical name occurs, a pause is made for description—to paint in words, as it were, the scene of each act in the drama. The result is effective, but so desirous is the author of avoiding features unattractive to his young readers, that he has a tendency to omit perhaps desirable facts—dates, for example.

'Florence and the Cities of Northern Tuscany, with Genoa.' By Edward Hutton. (London: Methuen. 1907. Pp. x., 436. *Map and Illustrations.*) A great part of this book consists of personal meditation and narrative, but there is also plenty of historical and descriptive matter. Such a book is probably most attractive to the reader who has covered the ground, and can compare his views with the author's. In this case he would probably dispense gladly with most of the coloured illustrations; those in monotone are more successful. The map is a sketch in Mr. B. C. Boulter's antique manner, picturesquely suitable.

Asia.—'Indian Jottings.' By E. F. Elwin. (London: Murray. 1907. Pp. xi., 314. *Illustrations.*) The sub-title of this book is, 'From Ten Years' Experience in and around Poona City,' and the author, a member of the Society of St. John the Evangelist, Cowley, deals with "the ordinary life and surroundings of the mission worker in India." The book is, in fact, almost entirely a study of native character, written with intimacy and interest.

America.—'Guide to Modern Peru.' By A. de Clairmont, Consul of Peru. (Toledo, Ohio. 1907. Pp. 66. *Illustrations.*) In the attempt to inspire the reader with a proper conception of the commercial possibilities of Peru (the chief purpose of this book), the writer's style often resembles that of a patent-medicine advertiser. "There is not a country to compare with it in the world," he says; he might, perhaps, have added to the value of his arguments by giving the other side of the picture.

'Reise in das Moderne Mexico.' By Mietze Diener. (Vienna: Hartleben. 1908 [1907]. Pp. 112. *Map and Illustrations.*) This volume is a "souvenir" of the tenth International Geological Congress held in Mexico City. The journey or series of excursions was comprehensive, extending from Mexico City to the extreme

north of the country; to Saltillo and the vicinity, and to the south. The book is a fairly illustrated narrative.

Pacific.—'Maori and Polynesian: Their Origin, History, and Culture.' By J. Macmillan Brown. (London: Hutchinson. 1907. Pp. xxxi. and 300.) To all who are attracted by the mysteries of an inexact science, ethnography, so far as it is one, must be specially attractive. This book, piecing together as it does, by a series of brilliant inferences from scanty knowledge, the story of the origin of two of the most interesting peoples in the world in this respect, cannot but be read with deep interest, especially as the author has to no great extent had to follow well-trodden tracks.

'In the Strange South Seas.' By Beatrice Grimshaw. (London: Hutchinson. 1907. Pp. x. and 381. *Illustrations.*) From this writer an entertaining description of the islands visited (Tahiti, New Zealand, and others) would be expected, and is certainly provided in this book. The photographs, moreover, are particularly good, and give no mean idea, within their limits, of the beauties of the south seas.

General.—'Guide to the Great Game Animals (Ungulata) in the Department of Zoology, British Museum (Natural History).' (London: By order of the Trustees of the Museum. 1907. Pp. viii., 93. *Illustrations.*) In this handbook an indication is generally given of the geographical distribution of Genera and species, not only at the present time, but also in many cases in former geological epochs.

'The Mammoth Hunters.' By Alfred E. Carey. (London: Greening. 1907. Pp. xii., 306. *Plans and Illustrations.*) This is not specified as a book for boys and girls, but it is very suitable for them. It attracts their attention by the opening story of the discovery of a cave by children, and its subsequent exploration by their elders, and out of this episode is developed, with simple interest, a study of the conditions of the life of men "in the morning of the world," and other kindred matters.

'Modern Lithology illustrated and defined.' By Ernest H. Adye. (Edinburgh: W. & A. K. Johnston. 1907. Pp. 128. *Illustrations.*) This should be a most useful work of reference. The text consists mainly of explanation of the admirable coloured illustrations of various rock textures, executed with great delicacy, and beautifully printed. There are, besides, a short bibliography, glossary and index.

THE MONTHLY RECORD.

EUROPE.

The Scottish Peat-mosses.—A third paper on this subject (*Journal*, vol. 27, p. 84; vol. 30, p. 88), contributed by Mr. F. J. Lewis to the *Transactions of the Royal Society of Edinburgh* (vol. 46, part i., No. 2), embodies the results of further fieldwork during 1906, and is, besides, of special interest as summarizing the conclusions to be drawn from the whole investigation. The field of work in 1906 embraced four areas—the first two in the Highlands, and offering examples of valley and upland deposits respectively; the last two embracing parts of the Outer Hebrides and Shetland islands. Of the Highland valley deposits, those of the Parph, Cape Wrath, showed a general agreement with those examined previously in Inverness-shire, Easter Ross, and Caithness, with the exception that the upper forest bed was wanting in the former. In the Assynt district of Sutherland, the arctic plants at the base of the peat were absent, but the upper forest bed was represented, generally in the form of two zones (*Betula alba* and *Pinus sylvestris*) separated by a layer of peat, as in other Highland districts. The upland deposits

of the Forfarshire Grampians showed three distinct types, varying in the age of the peat, but all showing the upper forest bed, though in some cases its upper tier is replaced by a bed formed almost entirely of Calluna stems. The Moor of Rannock showed less regularity, especially in the lower layers, as might be expected in a badly drained area liable to flooding. The double tier of trees in the upper forest bed is hardly noticeable here. Both in the Outer Hebrides and in the Shetlands, a lower arctic bed not seen elsewhere was a marked feature, while, though the upper forest bed of the mainland was entirely wanting, the lower forest bed could generally be distinguished. During the whole investigation Mr. Lewis was able to define nine distinct beds, beginning from a basal ("first") arctic bed, and passing through a lower forest bed; a lower and upper bed of peat separated by a second arctic bed; and two tiers of an upper forest bed separated by peat with arctic plants; to the recent peat at the surface. He discusses the geographical distribution of these several beds, and illustrates it graphically by a couple of sections carried through all the principal areas examined. As already noted, the first or lower arctic bed was found only in the Hebrides and Shetlands, its character being different in the two localities. The lower forest shows a somewhat remarkable distribution, being found in the southern uplands, in the Hebrides and Shetlands, but not in the Highlands. It seems that the path of the Atlantic cyclonic systems must, at the time of its existence, have been different to the present; the existing absence of trees from the Shetlands being due, not to temperature, but to the force of the salt-laden winds. No characteristic arctic plants are found in the lower forest bed, and it may be supposed that while the first arctic bed points to a depression of the present alpine-arctic boundary to an extent of 2000 feet, the lower forest bed represents the return of that boundary to at least its present altitude. The lower peat-bog is widely developed, though tending to thin out from south to north, and showing a variation of type in some lowlying districts. The second arctic bed is represented in every district examined along a line from the southern uplands to the Shetlands, though absent in Skye and the Hebrides. The upper forest bed is found on the mainland from the Wigtownshire lowlands to the valley of the Dionard. Some of its special features have already been alluded to. Mr. Lewis attempts to correlate the different beds with successive periods of glaciation, and gives a diagram showing the altitudinal limits of the various zones.

The Origin of the Iron Gate.—Among the results of Jovan Cvijić's investigations, carried on for several years, into the tectonic conditions at the Iron Gate, are the following: The breach made by the Danube, on the frontier between Servia on one side and Hungary and Rumania on the other, is 80 miles long, forming the longest breach-valley in Europe. The breadth of the river at its narrowest spot is only 380 feet, with a depth of indentation reaching to 1000 feet. As its precursor, the Iron Gate had a pre-Miocene valley. The floor of the valley, very broad, much warped and dislocated, is distinctly traceable at a height of 1300 feet above sea-level. During the second Mediterranean stage the sea penetrated into this valley, and it became a strait connecting the Pannonian with the Rumano-Russian sea. In the Pontic period there occurred a difference of level between the two seas, and the strait became a river. At about 2850 feet above the level of the present Danube, its valley-floor, strewn with great masses of boulders, may be clearly traced. This valley-floor, too, has suffered manifold disturbances. Besides these two old valleys, Cvijić has been able to establish the presence of seven Pliocene and Pleistocene Danubian terraces. Down-stream they gradually disappear, in consequence of the subsidence of the Rumanian basin. Up-stream, on the other hand, they are traceable as far as Belgrade, as also in the valleys of the Isker, issuing

from the Balkans, the Timok, and the Morava, as well as in the valleys of the Rumanian tributaries of the Danube, which burst through the Carpathians. On these terraces the history of the development of the Iron Gate down to the present time may be followed. As far back as the Pontic period, elevations occurred in the region of the Iron Gate. They find expression in two waves, the existence of these "waves of elevation" being deducible from the inverse inclination and dislocation of the terraces. They were the cause to which the cutting of the small V-shaped valley of the present Iron Gate into the broad Pontic valley-floor is to be attributed. That the course of the Danube reached back into pre-Miocene times is a fact confirmed by the conditions found at the breaches at Hainburg and Presburg, on the frontier between Austria and Hungary. The plan of the valley at Orsova is, moreover, connected with the very complicated structure of the Banat mountains. In the Cretaceous period these were subjected to an intensive folding with great over-thrusts, and in the long continental time of the older Tertiary they became almost completely levelled. In the place of the present gorge there then existed a broad valley, the situation of which was indicated by a longitudinal rupture. Before the second Mediterranean stage the subsidence of the great basin took place. During this stage a rise in the sea-level occurred, and the valley grew into the already-mentioned strait. The rushing stream that thence was formed in the Pontic period drained the Pannonian basin. Then ensued a renewed elevation of the land, the old valley-floors became again warped, and the river incised its passage anew. In Pliocene times a subsidence of the basins again occurred. This was perhaps connected with the forcing up of the mountain barriers, a circumstance serving to explain the low terraces.

ASIA.

Dr. Hedin's Explorations.—A letter from Dr. Hedin, printed in *Petermanns Mitteilungen*, No. 1, 1908, supplements previous accounts to some extent, though all the essential points have already been referred to in the *Journal*. It is dated "Gartok, October 7, 1907," and runs as follows: "Here in Gartok I have completed a new section of my journey. It is exactly half a year since I left Shigatse, and many great and important discoveries have been made in the interval. The great range, which I first crossed at the Sela-la, I have now surmounted by four other high passes, and so have been able to trace its course. It is an enormous chain, certainly not inferior in length to the Himalayas, and the mean height of the passes is greater; only in the height of the peaks do the Himalayas of course retain the advantage. From Shigatse I followed generally the Ragha-tsanpo, and went as far as the Targut-gangri and the neighbourhood of the Dangra-yum-tso; to the south of it is a very large lake, the Shuru-tso. From Tradum I crossed the water-shed between Tibet and India and paid a short visit to Nepal. Then followed the discovery of the source of the Brahmaputra, which comes from a huge glacier mass, the Kubi-gangri, belonging to the northernmost chain of the Himalayas. The supposition of Nain Singh that the Mariam-la is the origin of the river is entirely wrong, for only one of the smallest tributaries descends from this pass.* Then for five weeks I studied the Satlej problem. The real source of this river lies, not where it is marked on maps, but two long days' journey east-south-east of Manasarowar. On the same pass from which the most westerly branch of the

* It may be observed that the stream descending from the Mariam-la has been shown merely as a side-branch on all the best English maps since the journey of Nain Singh in 1865. The latter reported the main branch to be fed by many large glaciers

Brahmaputra flows eastwards, begins the river Tage-tsanpo, which falls into the Manasarowar, and at my visit discharged 11 cub. metres (389 cub. feet) of water per second; altogether 31 cub. metres (1095 cub. feet) flow into the lake. There is no longer any visible connection between the two lakes, but the water passes underground from Manasarowar into Rakas-tal, and from this again by an underground channel further west, appearing again in the form of innumerable springs in the old Sutlej bed. I have made a very exact bathymetrical map (129 soundings) of the Manasarowar (Tso-mavang). Then I made the pilgrim journey round the Kailas, and, from the temple Diri-pu, an excursion to the source of the Indus, where, so far as I know, no European has been hitherto. The source is called by the Tibetans Singi-Kabap—that is the mouth, out of which the Indus comes. From here I travelled north-eastwards through unknown country to Yumba-matsu in 32° N. lat., and then back to Gartok, crossing the Indus again. As Ryder and Rawlings had made the journey from Shigatse to Gartok, I tried to avoid their route, and of about 135 days' marches only 2½ lay along it. They accomplished their journey in 72 days, and I in exactly six months, for I made many excursions to the north and south. Maps—as, for instance, that in Stieler's atlas—must now undergo many extensive alterations. Especially remarkable will be a quite new gigantic range right across the whole of Tibet, for the Nin-jeng-tang-la, to the south of the Tengri-nor, is the same chain which I crossed a few days ago to the north of Gartok by the high and difficult pass Jukti-la.* Since leaving Shigatse I have visited twenty-nine gunpas and accumulated hundreds of sketches; most of these temple cloisters were hitherto quite unknown. I have a very ample collection of observations. Reckoning from Shigatse, the map consists of 301 sheets with forty astronomical points, several hundred panoramas, which give a very good representation of the scenery and the general character of the highlands. I have also a series of precise measurements of the volume of water in the Brahmaputra and its tributaries, and an exact series of levels showing the difference between the Manasarowar and Rakas-tal (Langak-tso) equals 44 feet, or 14 metres. . . . Now I am on my way to Ladak. A year and three months in Tibet is enough for any ordinary man, and now another winter is beginning, with the thermometer already at a minimum of −21·3 C., as it was last night. It was not so cold at the same time last year further to the north and at greater elevations; perhaps this is because the rainy season has not put in an appearance."

Journeys in Hunan and Kiangsi.—An article by Captain Harfeld, with plan and illustrations, in the *Bulletin* of the Royal Belgian Geographical Society (vol. 31, Nos. 4 and 5), supplies a comprehensive description of north-west Hunan and west Kiangsi, from the point of view of topography, agriculture, mineral and commercial resources, etc. The first part (pp. 280–311) is devoted to a description of the rivers Siang Kiang and Yuen—their respective courses, tributaries, *régimes*, navigation, and the principal towns on their banks, including a minute account of the capital of Hunan. Thereon follow six itineraries: (1) From Ching Yu Wan and Fu Tai Shan (villages on the left bank of the Siang, 30 miles below Chang-Sha) to Chang Te Fu on the Yuen; (2) from Chang Te Fu to Tseu Chau on the

* The existence of such a range has long been suspected by geographers. Thus it was drawn by Mr. Brian Hodgson as a distinct and continuous chain under the name "Nyenchhen-thangla" ('Selections from the Records of the Government of Bengal,' No. 27, 1857). It was spoken of by Sir Clements Markham ('Bogle and Manning,' p. xxiv) as "the great northern chain of the Himalayas;" while Mr. Trelawny Saunders proposed for it the name "Gangri" (see map in the last-named work, and article in the *Geographical Magazine*, vol. 4, 1877).

Yuen; (3) from Chang Te Fu to Li Chau, a south to north route, which, crossing the Li by a fine stone bridge of eleven arches, enters the prefectorial town of Li Chau with 200,000 inhabitants; (4) from I Yang Hsien to Chang-Sha by Niog Khiang Hsien; (5) Siang Tan to Ngan Yuen (in Kiangsi); (6) from Chu Chau (Central Hunan) to Li Ling (in west Kiangsi). The article concludes with the journal of two journeys: one through west Hunan, made early in 1904; the other through east Hunan, made in the corresponding part of 1903. The mineral riches of north-west Hunan and west Kiangsi are stated to be immense, as testified by the relatively brilliant results of Chinese enterprise in this field in various places. The principal minerals of commercial value include gold (rich veins of auriferous quartz having been exploited at Yu Ka Tson and Hu Lu Wan, while in other parts there is auriferous sand); argentiferous lead at various places, on the security of which the Carlowitz firm advanced money to the Chinese minister of railways; coal, of which there are numerous and important beds; iron, silver, copper, antimony, and zinc. As already said, there are detailed accounts of the principal towns. Chang-Sa, the capital of Hunan, extends nearly 2 miles along the right bank of the Siang, with a population of from 250,000 to 300,000. The busy part of the city is about 2 miles from the northern port. The place, however, of future importance is the sandy island (giving its name to the capital) I Shui Lu, 2 miles long by 500 feet broad, and 1000 feet distant from Chang-Sa. Below is another smaller island. Chang-Sha has a number of beautiful temples and numerous schools, including sixteen high schools, two military academies, and many private schools. Near the city a sacred hill rises out of a rich and fertile region to a height of over 1300 feet. Chang-Sha has important antimony and iron foundries, and manufactures paper, jewels, art furniture, etc. Its commerce absorbs a third of the foreign imports into Hunan, including cotton thread, plain and printed cottons, grey and white cloths, raw and woven silks, silk embroideries, linens, and furs. It likewise imports beans, pork, fresh and dried fish, rice, wines, German champaign, American corn, tea, cane-sugar, leaf and prepared tobacco, native and foreign opium, pipes, morphine, cheap American cigarettes, Japanese matches; rhubarb, camphor, and other medicinal plants; scents, musk, fashionable cloths, European and Japanese umbrellas, palm leaf and paper fans; gold, silver, and jade jewellery; petroleum from America, Sumatra, and Borneo; German lamps, candles, incense; objects in copper, white metal, and antimony, etc., etc. The revenue of the imperial customs at Chang-Sa rose from 35,000 taels in 1904 to 86,000 taels in 1905.

Cape Dezhnef, or East Cape.—Our honorary corresponding member, Colonel J. de Schokalsky, writes to us urging the general adoption of the name Dezhnef for the cape forming the most easterly point of Siberia, after the Russian seaman who was the real discoverer of Bering strait (1648). Colonel Schokalsky lays stress on the merits of this bold explorer, regretting that his name is less generally known than it deserves to be. It may be pointed out that the proposed adoption of his name for East Cape was referred to in the *Journal* some nine years ago (vol. 12, p. 609), and that it is now commonly found in English maps. The recent Admiralty charts all give the name Dezhnef (Deshnef) as well as the older appellation. The Russian explorer has been by no means unknown to English readers, as his achievements, so far as traceable, were made known in this country over a century ago, on the one hand through Jeffreys' translation of Muller's account of the Russian discoveries, and in the second through Coxe's work on the same subject.

AFRICA.

The Faro Tributary of the Benue.—This river, the confluence of which with the Benue was reached by Barth in 1851, has never been traced upwards to its source, although its upper course was touched at various points, a good many years ago, by the routes of Flegel. An examination of a portion of the river above the confluence of the Deo (the main western branch) has lately been made by Lieut. Strümpell (*Deutsches Kolonialbl.*, November 15, 1907). For two or three days above the junction this officer navigated the stream in canoes, but rapids then compelled him to take to the land, a way being cut with some difficulty through the uninhabited bush which covers the banks. At the farthest point reached (where the river still had a width of 50 to 100 yards), a view was gained of the plateau escarpment from which the stream descends, and in which its valley seems to form a sort of gulf. The lower country is broken by low hills and intersected by temporary streams. Below the confluence of the Deo the Faro has a wide sandy bed, with a shifting deeper channel, to which most of its water is confined in the dry season. Throughout this section it would be navigable for river-steamers. Above the Deo the river has higher banks, is rapid, and barred by serious obstructions, though some portion might be navigable. The country through which it flows was formerly much better peopled, remains of old settlements being frequently met with; but it has been depopulated by native wars. There are still some settlements of the Woko, who have proved a tractable people, though terrorized by their eastern neighbours, the Namji. Lieut. Strümpell thinks that if these latter were held in check, the country might be re-peopled by the pagan tribes of the region. Traces of elephants, buffalo, and other wild animals were seen, but the upper Faro valley does not abound in game to the extent that has been supposed. Under present conditions, the river above the Deo does not seem to offer great possibilities as a trade route. Of its course on the plateau above the descent of the escarpment, nothing appears to be known.

Vegetation Features of South-West Africa.—Even where the constituent elements of the Africa flora are fairly well known, there remains much to be done in the way of studying their distribution and ecological relations. A useful contribution in this direction has been made, in respect of the arid region of South-West Africa, by Mr. H. H. W. Pearson, who early in 1907 made a journey from Walfish bay to Windhuk, which he describes in the *Kew Bulletin*, 1907, No. 9. Apart from the notes on the vegetation, the paper gives some interesting information on the present economic position in that region. From Walfish bay—which seems to have fallen into a condition of almost complete stagnation since the port of entry into the German territory was transferred to Swakopmund—Mr. Pearson went on foot to Rössing on the Otavi railway, making the rest of the journey, outward and return, either by this or the Windhuk railway. The zone of sand-dunes, varied by mud flats, which is the first to be traversed, is about 7 miles wide at its narrowest. The flats here and there support a luxuriant growth of the Argentine *Nicotiana glauca*, which, according to Baines, was introduced about 1854, and has proved a most successful colonist. It reaches a height of 15 to 20 feet, and, with the native *Tamarix articulata*, supplies the wood used for the framework of the native huts and for fuel. Economically, the most important member of the flora is here the "Naras" (*Acanthosicyos horrida*), a cucurbitaceous plant, which sends down its roots to a great depth beneath the dunes, with the growth of which it keeps pace, its old buried stems, as stout as the human arm, serving in part as water-storers. For about four months in the year its nutritious seeds and the juicy flesh of its fruit form the chief food of the Hottentots.

At their eastern limit the dunes show no marked diminution in height, but are suddenly replaced by a gentle slope of ripple-marked sand leading up to the "Namib," a hard and stony plain rising eastwards to a height of about 2000 feet. There are many extensive areas on it where the plant-population is not more dense than three or four individuals to the acre. Towards the west there is an abundance of rounded, water-worn pebbles, and there is evidence in support of the view that the maritime belt has risen during recent times. The remarkable number of dry river-beds seem relics of a period of much greater rainfall, and the deeply eroded cañons of the Swakop and the Khan point to a similar conclusion. On the plateau the most characteristic plant is the curious fleshy-leaved *Zygophyllum Stapfii*, *Welwitschia* occurring more locally, while the main river-beds possess a much more abundant and less severely xerophytic flora. It seems doubtful whether the additional elements found here are due to the transport of seeds from the upper basins of the rivers, or whether the flora is a relic of one which spread all over the "Namib" when climatic conditions were more favourable, and of which only such species have maintained themselves on the plateau as could adapt themselves to the altered environment. Mr. Pearson inclines to the latter view. The soil temperatures obtained in the Namib on January 29–31 varied from 73°·6 Fahr. at 6 a.m. to 129°·2 at 2.45 p.m. At night, as is well known, this zone is remarkable for its fogs. Mr. Pearson found that seeds of *Welwitschia* which had been lying on the ground for six months exposed to the above fluctuations germinated within a fortnight under laboratory conditions. He considers that this region would be especially favourable for the establishment of a botanical laboratory for observations on desert life. There is a transition zone from the Namib to that of the "Acacia park forest," which extends to Windhuk, and includes some good grazing areas. On the plateau to the east of Windhuk the trees again become fewer and the undergrowth less abundant.

AMERICA.

The Currents in Belle Isle Strait.—The importance of this strait as lying on the most direct route from England to Montreal and Quebec, and its constantly increasing use by shipping, renders an accurate knowledge of the *régime* of its currents a matter of great moment. For a long time the erroneous belief prevailed that the current in the strait maintained a constant direction inwards, and this through its tidal character had been definitely ascertained, by Mr. M. H. Warren, in 1854. In 1894 a survey was carried out by the Marine Department of Canada, which once more established the true character of the currents in general outline (cf. *Journal*, vol. 8, p. 72).* A still more careful survey was made in 1906, in which year the whole season, from June 7 to September 22, was devoted to the strait, the most modern methods being employed in the investigation of the currents. The results have been put forward by Dr. Bell Dawson, the engineer in charge, in a special report issued by the Department of Marine and Fisheries (Ottawa, 1907). As was already demonstrated in 1894, the current in the strait is fundamentally of a tidal character, all the variations in the tide being represented by similar variations in the current, though this is complicated by a tendency to greater flow one way than the other. Thus, a berg may drift up and down with the flood and ebb, but in the course of a day will make on the whole a

* Reference is made, in the report now under review, to various journals in which attention was called to the results of the survey of 1894, the *Geographical Journal* not being among the number. It may be pointed out that those results were clearly stated in the volume above quoted, on the authority of the 'Report of the Survey of Tides and Currents,' etc., for 1895.

considerable gain in one direction, the average rate at which this gain is made sometimes amounting to over one knot per hour. But this greater flow may be either inwards or outwards, though during the whole of the observations there was almost always some dominant flow, which continued in one direction for periods varying from two or three days to two weeks and more at a time. It is this element of the current which brings the icebergs into the strait, or keeps it clear, as the case may be, and it is of much interest to discover the probable cause. Dr. Dawson examines in turn the various factors, astronomical and meteorological, which might be responsible for the phenomenon, and finds that there is no evidence of any true period of an astronomical character that can be assigned to the dominant flow; that it cannot be explained as a wind drift, though examples of such a drift have been met with in the strait; but that the cause is apparently related to general weather conditions acting indirectly. Thus difference of barometric pressure may occasion a change in the volume of the Gulf of St. Lawrence, through Cabot strait, which may react on the flow in Belle Isle strait; or more probably the effect may result from some fluctuation in the Labrador current, itself due to meteorological causes. Dr. Dawson suggests some practical indications of the probable direction of dominant flow at any given time.

The Nakimu Caves, British Columbia.—The report of Mr. A. O. Wheeler, Surveyor-General of Canada, for the year ending June 30, 1906, includes a detailed account of the Nakimu caves, highly interesting at once from a picturesque and a scientific point of view, recently discovered in the Selkirk mountains. The caves lie in Glacier Park Reserve, in the bed of Cougar Creek that has hollowed them out, and of the present channel of which they form part, 6 miles from Glacier house, the Canadian Pacific Railway hotel near the summit of Rogers pass. From Glacier house a bridle trail, 3·8 miles long, now leads to Cougar Water-tank, whence a bridle path of nearly 2 miles, now in course of construction, will, when finished, lead to the camp ground at the caves. The caves were first brought to public notice in 1904 by Mr. C. H. Deutschman. In 1905, twelve persons, including an underground engineer, visited the caves. In 1906, Mr. Wheeler made three visits—the first, preliminary; the second, for the purpose of surveying the entire valley and the enclosing peaks and locating the caves, so far as then known, above and below ground; the third, with a view to surveying the third and largest series of caves discovered two months previously by C. H. Deutschman. The caves comprise a labyrinth of passages cut through a ridge of dark blue limestone. At intervals the passages open into curious circular pot-holes, descending one to the other in a succession of steps. Into cavernous openings and deep abysses subterranean waterfalls leap with thunderous roar, intensifying the eeriness of the pitch-black depths glimmering under feeble lantern rays. Overhead project fantastically shaped spurs of rock. The visitor enters marble halls, with walls and ceilings frescoed in flowery designs of snowy whiteness, evoked into momentary vision by a flash-light. Throughout, the floors are of broken rock, seamed by cracks; in many places accessible only to skilled climbers. Outside the scene is almost equally weird, as the stream disappears and re-emerges at some depth below in a swirl of foaming cascades. A little more than a mile above the tank the exit of the underground flow from the caves is seen; higher up the volume of the stream is much shrunken. One-third of a mile above the outflow is the "wind crack," whence issues a shaft of cold wind. The report includes detailed accounts of the discovery, and a description of the valley of the caves, as well as of the individual caves with their formation and structure; also a topographical map of the Cougar valley, on a scale of 1 : 15,000, and a map of the cave system on a scale of 100 feet to an inch.

AUSTRALASIA AND PACIFIC ISLANDS.

Scientific Research in the Pacific.—It is announced in the *Pacific Commercial Advertiser* (Honolulu, December 14, 1907), that a body known as the Pacific Scientific Institution has been successfully organized, with a view to undertaking a complete scientific exploration of the Pacific ocean and its many islands. While the chief energies of the institution will be devoted to ethnology, the geology and configuration of the region will also be investigated, and studies in zoology and botany will be carried out, as also of winds and ocean currents with a view to throwing light on the distribution of animals, plants, and of the human race. Expeditions are to be despatched in a specially equipped vessel, and it is anticipated that fifteen years may be needed for the work. The moving spirit in the organization of the project is said to be Mr. W. A. Bryan.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Stereoscopic Colouring of Maps.—With reference to our note on this subject in the *Journal* for June, 1907, p. 680, Herr G. Freytag, of the Vienna cartographical firm of Freytag & Berndt, writes pointing out that the system of showing relief by means of a special arrangement of outstanding and retreating colours, has for some time been adopted in the publications of that firm, particularly in those intended for educational purposes. In addition to the use of this definite colour-scale, much has been done to improve the representation of *form* by a suitable distribution of light and shade.

Mountain-building in Miniature: Origin of Transverse Valleys.—The problem of the origin of valleys cutting transversely through mountain ranges has given rise to much discussion, the most commonly accepted explanations being either that the erosive action of running water has kept pace with the slow elevation of the range, or that the transverse valley has been formed by the backward-cutting of a stream which originally descended the outer slope. In the *Geographische Zeitschrift* for November, 1907, Dr. S. Passarge calls attention to an interesting case of mountain-building in miniature, which he thinks may throw light on the origin of some transverse valleys. A railway embankment thrown up near the station at Lychen (North Brandenburg) rested on the flank of a mass of diluvial sand, etc., at the spot where it dipped beneath an old lake-bed forming a level expanse of alluvium topped by a layer of turfy soil 3–5 feet in thickness. The pressure exerted by the embankment ridged up this turfy layer into a series of folds, the innermost and highest of which reached a height of 5 or 6 feet, while they died away outwards in a series of concentric rings, not continuous, but, as might naturally be expected, taking the form of a series of short overlapping arcs, highest in the centre and sinking towards the extremities so as to leave a series of depressions uniting the longitudinal furrows. But the most interesting point was the fact that these arcs had been frequently torn asunder transversely just at their highest point, giving rise to a series of fissures which closely reproduced the transverse valleys of many ranges. The whole formation offered a striking parallel to that of the Swiss Jura. This occurred in 1900, and the ridges have since lost much of their original sharpness, but a recent visit showed that the transverse fissures had been well maintained, and even, it seemed, accentuated. Without denying that the usual explanations may often hold good, Dr. Passarge thinks that this may sometimes at least have been the mode of origin of transverse valleys.

Lateral Erosion of Streams.—Prof. Mark Jefferson has lately paid some attention to the question of lateral erosion by streams, and has endeavoured to

ascertain in certain definite cases whether the process must be attributed to terrestrial rotation or to some other cause. The rivers examined are in the lower peninsula of Michigan, a drift-covered area out of which the rivers have carved winding valleys between grassy bluffs, while they themselves follow courses yet more winding on the floor of the flood-plain. Here and there the bluffs form "scaurs" or steep slopes of naked clay, these occurring at points where the meandering stream is now close to the valley wall. In 1903 Prof. Jefferson examined the scaurs on the lower Rouge river in company with Mr. I. Bowman, with a view to ascertaining what proportion of the valley was now subject to the widening process. It proved to be ten per cent., but Mr. Bowman noticed that for many miles two-thirds of the scaurs occurred on the *right* bank, and he suggested terrestrial rotation as the cause. To test this theory Prof. Jefferson has since undertaken the examination of other streams flowing in other directions, and the results have been presented to the Geological Society of America (*Bulletin*, vol. 18, 1907, pp. 333–350). It was found that most of the streams show persistent and uniform tendencies towards one or other side of their valleys wherever there is a flood-plain on which the streams meander between distinct bluffs. But though several bear strongly to the right, one at least bears as strongly to the left, whereas, if terrestrial rotation were the cause, the tendency of all should be towards the right. Prof. Jefferson is inclined to account for the tendency by the general tilting of the region towards South 27° W., which has been described by Gilbert.

HISTORICAL GEOGRAPHY.

A Historico-Geographical Document of the Fourteenth Century.—Mr. C. R. Beazley has done good service by printing in the *American Historical Review* (vol. 12, No. 4, and vol. 13, No. 1, July and October, 1907) an early document of much interest, which has hitherto received far less attention than it deserves. Apart from extracts printed in 1719 by Quétif in the 'Scriptores Ordinis Prædicatorum,' through which it was known to Sir Henry Yule ('Cathay and the Way Thither,' vol. 1, pp. 191–192), it has so far remained in manuscript, and though one copy is to be found in the library of Magdalen College, Oxford, it has been almost entirely disregarded by students. Under the title 'Directorium ad faciendum Passagium Transmarinum,' it consists of a memorial addressed about 1330 to King Philip VI. of France in the hope of stimulating a revival of the crusading energies of Western Europe, primarily against the Eastern Church, but also against the Moslems and other Eastern powers, the aim and ambition of the writer being the reduction of the whole of the Orient under Catholic rule. The name of the author remains unknown, though the work has been attributed to John de Cora, appointed Archbishop of Sultaniyah, in Northern Persia, in 1330, and the author of a 'Livre de l'Estat du Grant Caan.' But, as Mr. Beazley shows with much force, this identification is vetoed, not only by discrepancies as to actual facts, but by the entirely different mental attitude of the two writers, the author of the 'Directorium' being characterized by furious bigotry in regard to men of other faiths, of which no trace is to be found in the work of John de Cora. He had evidently been engaged in missionary work in Persia, besides making himself acquainted with Socotra, and his knowledge of the then existing conditions in the Eastern states, and their relations with the West and with each other, gives his work a decided interest from the geographical, as well as from the historical, point of view. Mr. Beazley has edited the text with great care, and while following to the letter what seems to be on the whole the most satisfactory manuscript (that of Paris), he has given in footnotes every divergent reading in the Magdalen copy, apart from mere differences of orthography. He has also supplied an interesting account of the work as a whole,

besides giving a brief analysis of its more important contents. Besides a general discussion of the motives for undertaking the crusade, in which the religious and general condition of the nations of Western Europe and Eastern Asia is fully entered into, there are sections on methods of action (including a scheme of siege operations against Constantinople), on the possible routes to be followed, and on the policy to be adopted in the governance of the conquered peoples. Among the more special objects of conquest was the empire of "Rassia," by which is to be understood, as Mr. Beazley points out, not the modern Russia, but the Servian empire of the fourteenth century which occupied nearly all the north-west of the Balkan peninsula. The work shows many analogies with the 'Secreta Fidelium Crucis' of Marino Sanuto the elder, and like this writer the author would absolutely interdict all maritime trade between Latin Christendom and the Moslem countries.

GENERAL.

The Royal Scottish Geographical Society.—We are pleased to learn that an annual grant of £200 towards the objects of this Society was sanctioned by the Treasury early in February. This should prove of material assistance towards the continuance and extension of the useful work accomplished by the Scottish Society since its foundation.

A New British Geographical Society.—We learn with much interest that active steps are being taken to establish a new provincial Society for the furtherance of geographical aims, under the title "The Leeds and Yorkshire Geographical Society." The promoters are Leeds public men, connected for the most part with the "Leeds Institute," and the meetings will be held in that city. A committee has been formed, and has already had under consideration the objects and constitution of the new body, which will include in its activities the arrangement of lectures, excursions and exhibitions, the publication of a journal, and the formation of a library. We understand that Lord Faber will probably be first President, while among the vice-presidents will be Mr. E. R. Wethey, of Bradford, whose services to geographical education in Yorkshire are well known. The stimulation of a local interest in geography is a work of much importance, towards which less has perhaps been done in this country than elsewhere, although local research must take a more and more prominent place in the geographical work of the future. We may anticipate valuable results from the new undertaking.

Lectureship in Geography at the University, Sheffield.—Through the liberality of Mr. Edgar Allen, of Sheffield, a Lectureship in Geography has been founded at the university of that city. Mr. Allen has already presented the university with a new library, which is in course of construction. The salary of the lectureship is £300. As will be seen from an advertisement in the current number of the *Journal*, applications are invited for the new post thus created. It is very significant of the rapid progress which has recently been made in the recognition of the importance of geography as an educational subject, that a lectureship should have been founded in so important a manufacturing and commercial centre as Sheffield. It may be useful to recall the fact that geography now forms a regular part of the curriculum at the universities of Oxford, Cambridge, London, Manchester, Liverpool, Birmingham, Sheffield, Aberystwith, and Edinburgh, and there is reason to believe that other universities will, ere very long, follow suit. There is thus considerable encouragement for really competent men to devote themselves to geography as a profession.

The Spelling of Place-names.—At the instance of Prof. Ricchieri, of the Accademia Scientifico-Letteraria, Milan, the reader of a paper on this subject at the

Sixth International Geographical Congress, held at London in 1895, the organizing committee of the Ninth International Geographical Congress, which is to meet at Geneva on July 27 of this year, has placed on the agenda of the congress the following question: What are the principal difficulties in the way of arriving at an international agreement on the transcription and orthography of geographical names, and in what manner can they be surmounted? Prof. Ricchieri, believing that if this problem is to be solved at all it can only be by slow stages and methodical procedure, proposes that all that should be aimed at in the first instance should be a preliminary agreement among a few men of different nationalities interested in this question as to the fundamental points on which it is necessary that an agreement should if possible be reached, and that a statement of those points should be laid before the Congress at Geneva, which should then be asked to appoint a small committee to study and procure the discussion of those points, and ultimately to draw up proposals and resolutions thereon. He further suggests that this committee should be expected to publish its proposals at least one year before the meeting of the next International Geographical Congress, which, it is hoped, might then be in a position to draw up final resolutions on the subject. This scheme of operations has received the support of Prof. Henri Cordier, of the École Spéciale des langues orientales, Paris; Prof. Robert Sieger, of the University of Graz; and Mr. G. G. Chisholm, Recognized Teacher of the University of London (Birkbeck College), who have agreed to co-operate with Prof. Ricchieri in drawing up the preliminary statement of fundamental points requiring solution to be laid before the Geneva Congress. If any Fellows of the Society have any suggestions on this question to make, and will kindly communicate them to Mr. Chisholm at his private address (59, Drakefield Road, Upper Tooting, S.W.), he will be glad to forward them to Prof. Ricchieri.

"**On North Polar Problems**"—**Erratum.**—In Mr. Harris's letter on this subject in the February number of the *Journal*, p. 227, line 10, "0·5 foot" should read "0·2 foot."

OBITUARY.

General Sir Richard Strachey, G.C.S.I., F.R.S., LL.D.

Amongst the names of those who have occupied the distinguished position of President of the Royal Geographical Society it may be doubted whether one could be selected with greater claim to the honour of lasting recognition by the scientific world than that of General Strachey. It is well said of him that in variety of his claims to distinction he may be regarded as "the most remarkable of the Stracheys, who for four generations and over a period of more than a century and a half have given to India the best portion of their lives;" for it is India that owes to Richard Strachey the deepest debt for his splendid achievements in the executive branches of her public works, as it owes to his equally distinguished brother John the development of much of her system of civil administration and finance. There was a time, indeed, when the Government of India was sarcastically called the "Government of the Stracheys," and this, too, when India was ruled by one of the ablest and most popular of her viceroys. For seventy years, commencing in the reign of William IV., was Richard Strachey a living force in India as practical engineer and scientific adviser, and it seems probable that such a record is unequalled in the annals of that country.

Born in 1817, he entered Addiscombe, the military school of the East India Company, in 1834; and after the usual two years' course of training, left as head of his term, and joined the cadre of that truly remarkable body of men whose names are equally distinguished in the military and civil history of India—John Company's engineers. There were opportunities then for men of the Strachey stamp. It was close on the period of India's awakening from a dreamy participation in oriental methods to a realization of her destiny as a great living factor in European politics and the necessity for adopting the main principles of economic development on the strenuous lines of the West.

From the very beginning Richard Strachey took up the white man's burden with the energy and confidence of a born leader, and whether he applied his high scientific ability to the training of waterways and irrigation through the dry spaces of upper India, working as a navvy in his shirt-sleeves, or whether, having donned the uniform of a soldier, he assisted with military plans and bridges to the conquest of the Sikhs, his whole heart was in his work. But the practical hand was always guided by the scientific brain, and it is hard to say whether as military engineer and Indian councillor, or as scientific investigator, he won the greatest fame. In the domains of botany, meteorology, geology, and physical geography he was equally at home as an original investigator, and his claims to distinction were fully recognized by the Royal Society, who conferred on him their medal, and elected him to be a Vice-President in company with such men as Spottiswood, Hooker, Huxley, and Kelvin.

As President and Councillor of the Royal Geographical Society we many of us remember him—the keen, determined face and the instant decision. There was no "uncertain sound" about Sir Richard Strachey's opinions, whether he fought the battle of the gauges of India (probably the only losing battle he ever did fight) or whether he laid down the rules on which scientific geography should be taught in England, he was equally clear in his views; and it is to him chiefly that we owe the change which has been effected in those methods of geographical instruction which have already borne such remarkable fruit. He was not over-anxious to publish his own records of geographical exploration to the world, instructive as they were. Knowledge and not advertisement was the objective of his enterprise, and so it was quite late in life, and under rather special circumstances, that he contributed the narrative of his journey to Lakes Manasarowar and Rakas Tal in Western Tibet. This expedition was undertaken in 1848, and only recorded for the information of the Society in 1900.

In the middle of the last century Tibet did not loom very large on the political horizon. The survey range of the Himalayas was for all practical purposes the ultimate boundary of British India, and the geography of that which lay beyond was a matter of absolute indifference to Government. It has taken just sixty years, from the first tentative expedition of Strachey over the border-line of Tibet to the present year of grace, to discover the position of the northern watershed of India. Indeed, until the return of the adventurous traveller, Sven Hedin, we shall not know even now exactly where to trace it on our maps. During those sixty years an immense impulse has been given to geographical discovery, and great has been the accumulation of knowledge in all branches of natural science relating to the Tibetan upland. But it is not too much to say that the information acquired by Strachey in that first excursion across the Himalayas, information geological, botanical, relating to glaciers and snowfall, or the nature and position of the sacred lakes which spread their blue surface to the sky within sight of the holy of holies—Kailas, has never been exceeded by any one traveller. In this as in every other work which he undertook, Sir Richard Strachey stands as a monument of

thoroughness. This quality indeed, added to his single-minded devotion to the best interests, not only of India, but of every undertaking which he controlled, is the key to his remarkable character and career. He died on February 9, 1908, at the advanced age of 91, and it may be written of him that his life's labours will surely be crowned with the wreath of immortality.

T. H. Holdich.

CORRESPONDENCE.

The Sources of our Present Information with regard to Lake Chad.

With reference to the review of Mr. Boyd-Alexander's 'From the Niger to the Nile' in the February *Journal*, I should like to call attention to the sources of our information about Lake Chad. When the geography of Africa was in its infancy, Denham and Clapperton gave us a real Lake Chad to replace the Lake Bornu of the early maps. Their journey was made in 1822–24, and Denham produced a map of the lake, except a portion of the east coast, which is dotted in. A quarter of a century after this Barth visited Chad, and, with his usual accuracy and care for detail, told us all he gathered from personal observation and otherwise, and even gave us the names of the thirteen islands that then existed; and Overweg confirmed Barth's statement. Vogel and Rohlfs were subsequently on the scene, and in 1870–72 Nachtigal examined the western and northern portion of its shores. From that time to the beginning of the present century Chad retained, on the maps, its stereotyped form, very much in the shape that Denham had depicted, until the remodelling was begun by Foureau, who in 1900, with Joalland, first gave a definite idea of the eastern shore; and the latter foreshadowed the separating cluster of islands in a map which was published in 1901.

Dubois, in April and May, 1902, surveyed the southern and south-eastern shore and islands, and his map appeared in the middle of 1903. The Lenfant Mission first gave the new shape to the lake, with the cluster of islands separating the two portions; and his map, which appeared on May 15, 1904, also shows the blocking up of the southern extension with marsh and swamp.

From the moment when Colonel Destenave took up the command of the Chad Military District, his officers have been ceaseless in their explorations of the lake. Audoin had been right round it and secured the general outline, and had spent much time surveying the clusters of islands; and after the completion of the work of the Niger-Chad Commission, Captain Tilho, with Audoin, D'Adhemar, Hardellet, and Jacques, covered the lake and its shores, the islands and marshes, with a network of routes. While D'Adhemar was surveying the south-eastern archipelago, the others were occupied on the south-eastern portion of the lake in December, 1902, August, 1903, and October, 1903, and surveyed the northern open water and its islands and shores in November, 1903, and March, 1904. The map embodying their work bears the imprint, "Aspect général en fin Avril 1904."

We have had this map, showing us the new state of affairs with regard to the lake, since the issue of the March number of *La Géographie* in 1906, and it is to the French officers that we owe, almost entirely, our present knowledge. Mr. Boyd-Alexander's book was published towards the end of last year, and in his map, which he bases on four positions determined astronomically by the French officers, he gives us some additional routes.

A. K.

Mr. Johnson's Ascent of E 61.

On p. 26 of the January number, and in reference to my remarks during the discussion of his paper, Dr. Workman says, "If any camp which Mr. Johnson thought approached this altitude (22,000 feet) was made, it must have been on the peak E 61, the only peak in the region exceeding 22,000 feet." He then points out that its assigned height of 23,890 feet was not accepted by the G.T.S., and goes on to say that therefore the altitude of Johnson's camp was wrongly estimated. Such a statement as this ought not to pass unnoticed in the *Geographical Journal*. Johnson's high camp was made in 1864, on his way to the Yarkand road from the neighbourhood of the Shayok river. He ascended E 61, many miles further to the east, in 1865, in the course of his celebrated journey to Ilchi (Khotan). Dr. Workman further implies that this question has only come up within the past year, but the mountaineering results of these two journeys were dealt with by Mr. Freshfield in the *Alpine Journal* for August, 1884, in which references are quoted.

Johnson's peak, E 61, is identical with K_5 of the G.T.S. and later maps ('Synopsis of Results,' etc., vol. 7, p. 40c, footnote and p. 281). In reference to its disputed height of 23,890 feet, which was omitted from the map accompanying Johnson's paper in the *Proc. R.G.S.* for 1867, it is interesting to note that in the map to illustrate Dr. Stein's paper in the *Geographical Journal* for December, 1902, this identical peak appears as Muztagh, with an altitude of 23,890 feet attached to it. This map also shows Cholpanglik Muztagh, 23,310 feet, 20 miles further to the south-west, and four other peaks over 23,000 feet in the same range.

There is no reason why a man who built "masonry platforms" at 21,500 feet, and took observations from a "quite extraordinary number of trigonometrical stations, which he established at over 20,000 feet" (*vide* Colonel Montgomerie in the *Proc. R.G.S.* for 1875), should not have reached an altitude of nearly 24,000 feet in such a region as the Kuen Lun.

TOM G. LONGSTAFF.

Ridgelands, Wimbledon, January 24, 1908.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1907–1908.

Sixth Meeting, January 27, 1908.—DOUGLAS W. FRESHFIELD, Esq., Vice-President, in the Chair.

ELECTIONS.—*Major John Grey Baldwin; Henry Balfour, M.A.; Bromley Challenor; Lieut. W. H. Coates, R.N.R.; Evan Lewis Davies; Captain Leonard William Lawson Everett; John William Edward Glover; Charles James Grist, M.A.; Major Lionel E. Kennard* (*15th Hussars*); *Georges Lecointe; Lieut. Francis Woodbine Parish* (*60th Rifles*); *George Platt; Thomas Smith; Captain Cyril Thornton; Rankin Wenlock; Arthur George Whitehorn-Cole, M.R.C.S.; Lloyd Williams.*

The paper read was:—

"Exploration and Climbing in the Gurhwal Himalayas." By Dr. T. G. Longstaff.

Seventh Meeting, February 10, 1908.—The Right Hon. Sir GEORGE T. GOLDIE, K.C.M.G., D.C.L., LL.D., F.R.S., President, in the Chair.

ELECTIONS.—*Henry Arthur Benyon; Fredk. Nicolai Dresing; James William Garson; Thomas B. Everard; Abdul Hamid; John William Leathley; Edward Fredk. William Lees, R.E.; James Black Love, M.A.; William Gilman Sewall; Major F. G. Talbot, D.S.O. (Rifle Brigade); John F. Wells.*

The paper read was:—

"The Story of London Maps." By Laurence Gomme.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Alps. *Quarterly J. Geol. S.* **63** (1907): 294-308. **Bonney.**

On the Southern origin attributed to the Northern Zone in the Savoy and Swiss Alps. By Prof. T. G. Bonney. *Diagrams and Sections.*

Alps. **Schmidt and Preiswerk.**

Beiträge Geol. Karte Schweiz **26** (1907): pp. 18 and 42.

Geologische Beschreibung der Leopontinischen Alpen. Von Prof. Dr. C. Schmidt und Dr. H. Preiswerk. I. Teil. *Map and Sections.*

Alps—Railway. **Hardmeyer.**

The St. Gothard railway. By J. Hardmeyer. 4th edition. (Illustrated Europe, Nos. 189-192.) Zurich: O. Füssli, [*not dated*]. Size 7½ × 5, pp. 114. *Maps and Illustrations.*

Austria—Alps. *G. Jahresb. Österreich* **5** (1907): 113-155. **Machaček.**

Die landeskundliche Literatur der österreichischen Alpenländer in den Jahren 1897-1905. Von Dr. Fritz Machaček.

Austria—Carniola. *Le globe; Mém. S.G. Genève* **46** (1907): 17–54. **Chaix.**

Contribution à l'étude des lapiés en Carniole et au Steinernes Meer. Par Emile Chaix et André Chaix. Avec un notice sur la Terra Rossa par Alfred Monnier. *Sketch-maps and Illustrations.*

Austria—Carniola. *Globus* **92** (1907): 12–15. **Mühlhofer.**

Der mutmassliche Timavotalschluss. Von Leutnant Franz Mühlhofer. *Sketch-map and Section.*

On the probable underground water-system of the Timavo.

Austria—Dalmatia. **Holbach.**

Dalmatia: the land where East meets West. By Maude M. Holbach. London: John Lane, 1908 [1907]. Size 8 × 5, pp. 236. *Map and Illustrations. Price 5s. net.*

Austria—Galicia. *G. Jahresb. Österreich* **5** (1907): 65–79. **Rudnyckyj.**

Beiträge zur Morphologie des galizischen Dniestergebietes. Von Dr. Stefan Rudnyckyj.

Belgium—Coal. ———

Coal-mining industry in Belgium. (Foreign Office, Miscellaneous, No. 664, 1907.) Size 9½ × 6, pp. 40. *Map, Illustrations, and Diagram. Price* 1*s.* 4½*d.*

Belgium—Meuse. *B.S. Belge Géologie* **21** (1907): 347–364. **Briquet.**

La vallée de la Meuse en aval de Liége. Par A. Briquet. *With Sketch-maps and Section.*

Europe—Historical. **Temple.**

The travels of Peter Mundy in Europe and Asia, 1608–1667. Vol. 1, Travels in Europe, 1608–1628. Edited by Lieut.-Colonel Sir Richard Carnac Temple. Cambridge, 1907. Size 9 × 5½, pp. lxiv. and 284. *Maps and Facsimile Illustrations. Presented by the Hakluyt Society.*

Färoes. **Currie.**

The mineralogy of the Faeröes arranged topographically. By James Currie. (From the *Transactions of the Edinburgh Geological Society*, vol. **9**, part i.) Size 8½ × 5½, pp. 68. *Map and Illustrations.*

France. **Vidal de la Blache.**

[Paul] Vidal de la Blache. La France: tableau géographique. Paris: Hachette et Cie., 1908 [1907]. Size 12 × 9, pp. viii. and 366. *Maps and Illustrations. Price 25 fr. Presented by the Publishers.*

See review of the first edition in vol. **23**, p. 111. The illustrations form the principal addition in the present issue.

France—Alpes Maritimes. **Guébhard and Others.**

Les Préalpes Maritimes. Par Adrien Guébhard. . . . 2 vols. Paris, etc., 1904–1906. Size 10 × 6. *Illustrations and Sections. Presented by the Author.*

Vol. 1, by M. Guébhard, describes geological excursions in the outer Alps. Vol. 2 is a collection of more technical papers by various authors.

France—Basses Alpes. *Ann. G.* **16** (1907): 223–244. **Levainville.**

La vallée de Barcelonnette: notes de géographie humaine. Par J. Levainville. *With Sketch-map.*

France—Touraine. **Miltoun.**

Castles and chateaux of old Touraine and the Loire country. By Francis Miltoun. London: Sir I. Pitman & Sons, 1907. Size 8 × 5½, pp. xii. and 348. *Map and Illustrations. Price 7s. 6d. net.*

Germany—Hamburg. **Uetzmann.**

Die geographische Lage Hamburgs. Dissertation zur Erlangung der Doktorwürde. . . . Von Richard Uetzmann. Hamburg, 1906. Size 9 × 6, pp. 56. *Plan. Price 2s.*

An instructive study on the influence of geographical position on the development of Hamburg.

United Kingdom—Hertfordshire. **Fordham.**

Hertfordshire maps: a descriptive catalogue of the maps of the county, 1579–1900. By Herbert George Fordham. Hertford, 1907. Size 11½ × 9, pp. xii. and 182. *Facsimile-maps and Portrait. Presented by the Author.*

A preface, notes, and indices have been added in this collective issue.

United Kingdom—Historical. **Holmes.**

Ancient Britain and the invasions of Julius Cæsar. By Dr. T. Rice Holmes. Oxford: Clarendon Press, 1907. Size 9 × 6, pp. xvi. and 764. *Maps and Illustrations. Price* 21*s. net. Presented by the Publishers.*

United Kingdom—Historical. **Marshall.**

Through Great Britain and Ireland with Cromwell. By H. E. Marshall. London: T. C. & E. C. Jack, [*not dated*, 1907]. Size 7 × 5, pp. x. and 142. *Maps and Illustrations. Price* 1*s.* 3*d. Presented by the Publishers.*

United Kingdom—Scotland. **Adam.**

The clans, septs, and regiments of the Scottish Highlands. By Frank Adam. Edinburgh, etc.: W. & A. K. Johnston, 1908 [1907]. Size 9 × 5½, pp. xxiv. and 506. *Map and Illustrations. Price* 15*s. net. Presented by the Author.*

United Kingdom—Waterways.

First Report (with Minutes of Evidence and Appendices) of the Royal Commission appointed to inquire into and to report on the Canals and Inland Navigations of the United Kingdom (pp. viii., x., 470, and 112). Second Report (with Minutes of Evidence and Appendices) of the same (pp. viii., xii., 322, iv., and 56). London, 1906 and 1907. *Maps. Prices* 6*s. and* 3*s.* 9*d. Presented by the Royal Commission.* [To be noticed elsewhere.]

ASIA.

Burma and Mesopotamia. **Beylié.**

Prome et Samara: voyage archéologique en Birmanie et en Mesopotamie. Par le Général L. de Beylié. Paris: E. Leroux, 1907. Size 11 × 7½, pp. 146. *Plans and Illustrations. Presented by the Author.*

Central Asia. *B. Ecole Française Extrême Orient* **6** (1906): 255–269. **Pelliot.**

Notes sur l'Asie Centrale. Par Paul Pelliot. *Plans.*

Ceylon—Surveys. **Warren.**

Ceylon. Administration report, 1906. Part i. Civil Survey report of Mr. P. D. Warren, Surveyor-General. Size 13 × 8, pp. 34. *Map, Illustration, and Diagrams. Presented by the Surveyor-General.*

China. **Richthofen and Tiessen.**

Ferdinand von Richthofen's Tagebücher aus China. Ausgewählt und herausgegeben von E. Tiessen. 2 vols. Berlin: D. Reimer, 1907. Size 9½ × 6½, pp. (vol. 1) xiv. and 588; (vol. 2) iv. and 376. *Map and Illustrations. Price* 20*m. Presented by the Publisher.* [To be reviewed.]

China. **Willis and others.**

Research in China. Vol. 1, Part i. Descriptive topography and geology, by Bailey Willis, Eliot Blackwelder, and R. H. Sargent. Part ii. Petrography and Zoology, by Eliot Blackwelder; Syllabary of Chinese sounds, by Friedrich Hirth. [Atlas of] Geographical and geological maps. Washington: Published by the Carnegie Institution, 1906–07. Size (volume) 11½ × 9; (atlas) 22 × 18½, pp. xiv., iv., 528, and xxiv. *Maps and Illustrations. Price* 62*s.* 6*d.* [To be reviewed.]

China—Chili. *Petermanns M.* **53** (1907): 201–204. **Berg.**

Das Trappistenkloster Yan-kia-ping, westlich von Peking. Von Oberleutnant Detloff v. Berg. *With Map.*

China—Historical. **Sargent.**

Anglo-Chinese commerce and diplomacy (mainly in the nineteenth century). By A. J. Sargent. Oxford: Clarendon Press, 1907. Size 9 × 5½, pp. xii and 332. *Diagrams. Price* 12*s.* 6*d. net. Presented by the Publishers.* [To be reviewed.]

China—Ports. **Hosie.**

Report on visit to southern ports of China. By Sir A. Hosie. Foreign Office, Miscellaneous No. 665, 1907. Size 9½ × 6, pp. 12.

China—Trade.

China: Imperial Maritime Customs. I. Statistical Series, No. 7. Native customs trade returns. No. 3, Quinquennial reports and returns, 1902–06. Shanghai, 1907. Size 11 × 8½, pp. 122. *Maps.*

Chinese Empire. **Filchner and others.**

Wissenschaftliche Ergebnisse der Expedition Filchner nach China und Tibet, 1903–1905. 10 Band, I. Teil. 1. Abschnitt: Zoologische Sammlungen. 2. Abschnitt:

Botanische Sammlungen. Berlin: E. S. Mittler u. S., 1908 [1907]. Size 10 × 7, pp. xii. and 288. *Map and Illustrations. Presented by Lieut. Wilhelm Filchner.*

Reports by a number of experts.

India.

Administration report of the Marine Survey of India, 1906–1907. Bombay, 1907. Size 13 × 8½, pp. 12.

India—Bengal. **Cunningham.**

Plagues and pleasures of life in Bengal. By Lieut.-Colonel D. D. Cunningham. London: John Murray, 1907. Size 9 × 5½, pp. xii. and 386. *Illustrations. Price* 12*s. net. Presented by the Publisher.*

India—Burma. **Ireland.**

Colonial Administration in the Far East. The province of Burma: a report prepared on behalf of the University of Chicago. By Alleyne Ireland. 2 vols. Boston, etc.: Houghton, Mifflin & Co., 1907. Size 10½ × 7, pp. xxii., xvi., and 1024. *Maps. Price* $20.

India—Himalaya. *Records Geol. Surv. India* **35** (1907): 123–137. **Hayden.**

A preliminary survey of certain glaciers in the North-West Himalaya. By Officers of the Geological Survey of India.

Notes on certain glaciers in North-West Kashmir. By H. H. Hayden. *With Maps and Illustrations.*

India—Historical. **Biddulph.**

The pirates of Malabar, and An Englishwoman in India two hundred years ago. By Colonel John Biddulph. London: Smith, Elder, & Co., 1907. Size 8 × 5, pp. xx. and 328. *Map and Illustration. Price* 6*s. net.*

India—Mergui Archipelago. *Scottish G. Mag.* **23** (1907): 463–483. **Brown.**

The Mergui Archipelago: its people and products. By R. N. Rudmose Brown. *With Illustrations.*

The writer lately paid a visit to this imperfectly known archipelago for the purpose of studying its pearl fishery.

India—Tide-tables. **Burn, Selby, and Hunter.**

Tide-tables for the Indian Ports, 1908 (also January, 1909). By Major J. M. Burn, F. J. Selby, and J. de Graaff Hunter. 2 parts, pp. 1236.

Japan—Bibliography. **Wenckstern.**

Bibliography of the Japanese empire. Being a classified list of the literature in European languages relating to Dai Nihon [Great Japan]. . . . Vol. 2, comprising the literature from 1894 to the middle of 1906. . . . Compiled by Fr. von Wenckstern. Tokyo (London: B. Quaritch), 1907. Size 10 × 5½, pp. xvi., 486, 28, and 22. *Presented by the Publisher.*

Evidently compiled with great care and labour. Vol. 1, dealing with the years 1859–93, appeared in 1895.

AFRICA.

Abyssinia. *Riv. G. Italiana* **14** (1907): 490–491. **Tancredi.**

Un vulcano della Dancalia in eruzione. Del Cap. A. M. Tancredi.

A new focus of eruption is reported to have been formed on the western flank of Mount Afdera, in about 13° 15′ N.

Abyssinia. **Beccari and Almeida.**

Rerum Æthiopicarum scriptores occidentales inediti a sæculo xvi. ad xix., curante C. Beccari. Vol. 5. P. Emmanuelis d'Almeida. Historia Æthiopiæ; Liber i.–iv. Rome, 1907. Size 10½ × 7½, pp. lxiv. and 526. *Facsimile Map. Price* 20*s.* 8*d.*

The editor supplies a critical introduction, in Latin, of 64 pp., and there is a facsimile of the original map.

Africa—Islam. *Questions diplomatiques* **24** (1907): 436–447. **Gaden.**

Les états musulmans de l'Afrique centrale et leurs rapports avec la Mecque et Constantinople. Par le Commdt. Gaden.

Africa—Meteorology. *T.S. African Philosoph. S.* **16** (1907): 437–442. **Claxton.**

Note on the connection between the rainfall at Durban and Mauritius. By T. F. Claxton.

Africa—Railways.

Die Eisenbahnen Afrikas: Grundlagen und Gesichtspunkte für eine koloniale Eisenbahnpolitik in Afrika. Nach der gleichnamigen amtlichen Denkschrift herausgegeben vom Kolonialpolitischen Aktionskomitee. Berlin: W. Süsserott, 1907. Size 10 × 7½, pp. viii. and 164. *Maps. Presented by the Kol. Aktionskomitee.*

Algeria. *A travers le monde* **13** (1907): 345–348. **Desfontaines.**

Les territoires du sud de l'Algérie: limitation nouvelle et situation économique. Par C. Desfontaines. *Sketch-map and Illustrations.*

Angola.

Report for the year 1906 on the trade and commerce of Angola. (Foreign Office, Annual, No. 3928, 1907.) Size 9½ × 6, pp. 40. *Price* 2½*d.*

British East Africa. **Hutchins.**

East Africa Protectorate. Report on the forests of Kenia. By D. E. Hutchins. Colonial Report, Miscellaneous, No. 41. London, 1907. Size 9½ × 6, pp. 40. *Price* 2½*d.*

See note in the February number, p. 218.

British East Africa.

Papers relating to British East Africa. London, 1907. Size 13 × 8½, pp. 62. *Price* 6*d.*

Concerned chiefly with the land-settlement question.

British West Africa—Cotton.

The British Cotton-growing Association. [Publication] No. 22. Experimental work in West Africa. No. 2. Manchester, 1907. Size 8½ × 5½, pp. 48.

Egypt and Sudan. **Baedeker.**

Egypt and the Sudân. Handbook for travellers by Karl Baedeker. Sixth remodelled edition. London: Dulau & Co., 1908 [1907]. Size 6½ × 4, pp. clxxxiv. and 440. *Maps and Plans. Price* 15 *marks. Presented by the Editor.*

The editor has had the collaboration, amongst others, of the well-known Egyptologist, Prof. G. Steindorff, of Leipzig.

French Congo. **Chevalier.**

Mission Chari—Lac Tchad, 1902–1904. L'Afrique Centrale Française: récit du voyage de la mission par Auguste Chevalier. Paris: A. Challamel, 1907. Size 11 × 7½, pp. xvi. and 776. *Maps and Illustrations. Price* 20 *fr. Presented by the Author.* [To be reviewed.]

Somaliland, British. **Swayne.**

A woman's pleasure trip in Somaliland. By Frances Swayne. London: Simpkin & Co., 1907. Size 7½ × 5½, pp. xii. and 172. *Sketch-map and Illustrations. Presented by the Author.*

South Africa. **Brown.**

The guide to South Africa . . . edited annually by A. Samler Brown and G. Gordon Brown. 15th edit., 1907–1908. London: Sampson Low & Co., [1907]. Size 7½ × 5, pp. lvi. and 478. *Maps, Plans, and Sections. Price* 2*s.* 6*d. Presented by the Union Castle Mail Steamship Co.*

NORTH AMERICA.

Alaska. *J. Geology* **15** (1907): 415–433. **Blackwelder.**

Glacial features of the Alaskan coast between Yakutat Bay and the Alsek River. By Eliot Blackwelder. *With Map and Illustrations.*

Alaska. *U.S. Geol. Surv. B.* **287** (1907): pp. xii. and 162. **Spencer and Wright.**

The Juneau gold belt, Alaska, by Arthur C. Spencer; and A reconnaissance of Admiralty Island, Alaska, by Charles Will Wright. *With Maps, Illustrations, and Diagrams.*

America—Ethnology. **Friederici.**

Der Tränengruss der Indianer. Von Dr. Georg Friederici. Leipzig: Simmel & Co., 1907. Size 9½ × 5, pp. 22. *Price* 1*m. Presented by the Publishers.*

California—Colorado River. *Scottish G. Mag.* **23** (1907): 360–363. **Redway.**

The Vagaries of the Colorado River. By Jacques W. Redway. *With Map.*

Written before the river was finally brought under control. (*Journal*, vol. 30, p. 564).

California—Sierra Nevada. *Appalachia* **11** (1907): 239–248. **Church.**

Summit temperatures in winter in the Sierra Nevada. By J. E. Church. *With Illustrations.*

Canada—Gulf of St. Lawrence. **Dawson.**

The currents in Belle Isle Strait, from investigations of the Tidal and Current Survey in the seasons of 1894 and 1906. W. Bell Dawson in charge. Ottawa, 1907. Size 10 × 6½, pp. iv. and 44. *Chart and Diagrams.*

Canada—Historical. *P. and T.R.S. Canada* **12** (1906): Sect. 1, 65–81. **Prud'homme.**

Les successeurs de La Vérendrye sous la domination française. Joseph Fleurimont de Noyelles, Jacques Repentigny Le Gardeur, Sieur de Saint-Pierre, et Saint-Luc de la Corne; 1743–1755. Par L. A. Prud'homme.

Canada—New Brunswick. *B. Nat. Hist. S. New Brunswick* **5** (1907): 519–546. **Ganong.**

Notes on the Natural History and Physiography of New Brunswick. Nos. 101–106. By W. F. Ganong. *With Maps.*

Continuation of the valuable series of papers, which has been in course of publication for some years.

Canada—Relief. *P. and T.R.S. Canada* **12** (1906): Sect. iv., 67–82. **Poole.**

Features in the continental shelf off Nova Scotia. By H. S. Poole. *Map.*

Canada—Rocky Mountains. *Appalachia* **11** (1907): 221–229. **Walcott.**

The first ascent of Mount Mummery. By Robert Walcott. *With Illustrations.*

United States—Commercial. **Oppel.**

Wirtschaftsgeographie der Vereinigten Staaten von Nordamerika. Von Prof. Dr. A. Oppel. (Angewandte Geographie . . . III. Serie, 2 Heft.) Halle a. S.: Gebauer-Schwetschke, 1907. Size 8½ × 5½, pp. [vi.] and 160. *Diagrams. Price* 3*s.* 6*d.*

United States—Virginia. **Kingsbury.**

The records of the Virginia Company of London. The Court Book, from the manuscript in the Library of Congress. Edited . . . by Dr. Susan Myra Kingsbury. 2 vols. Washington: Government Printing Office, 1906. Size 11½ × 9, pp. (vol. 1) 636; (vol. 2) 612. *Facsimiles. Price* $4.

A reprint of a document of great importance for the early history of British enterprise in America. There is a good introduction and other illustrative matter.

CENTRAL AND SOUTH AMERICA.

Argentine. *La G., B.S.G. Paris* **16** (1907): 81–100. **Schrader.**

En Argentine. Par F. Schrader.

Impressions gained during two visits to the country.

Argentine Exhibition. [**Holder.**]

A record of the proceedings of the British Argentine Exhibition held in Buenos Aires, November 25th to 29th, 1905. [Compiled by A. Holder.] Buenos Aires, [1906]. Size 10½ × 7, pp. 124. *Maps and Diagrams. Presented by Señor F. Moreno.*

Argentine—Population. **Carrasco.**

El crecimiento de la poblacion de la República Argentina 1895–1906. Por Gabriel Carrasco. Buenos Aires, 1907. Size 10½ × 7, pp. 14.

Bolivia. **Crespo.**

Ministerio de Colonización y Agricultura. Indicaciones sumarias para el immigrante á Bolivia. Por Luis S. Crespo. La Paz, 1907. Size 8 × 5½, pp. vi. and 160. *Maps and Illustration.*

Bolivia. *Tour du Monde* **13** (1907): 37–48, 421–456. **Barbier.**

Un pays jeune du Pacifique: la Bolivie. Par Émile Barbier. *With Sketch-maps and Illustrations.*

Bolivia. **Vacano and Mattis.**

Bolivien in Wort und Bild. Aus seiner Vergangenheit, Gegenwart und Zukunft. Von Max Josef von Vacano und Hans Mattis. Berlin: D. Reimer, 1906. Size 10 × 7, pp. viii. and 234. *Map and Illustrations. Price* 10*s.*

A descriptive account of the country.

Bolivia—Ethnology. **Quevedo.**

La lengua Leca de los rios Mapirí y Beni según los MSS. de los PP. Cardús y

Herrero. Arreglados y anotades por S. A. Lafone Quevedo. Buenos Aires, 1905. Size 10 × 6½, pp. 5–180. *Map.*

Brazil—Bahia. *B.S.G. Com. Bordeaux* **30** (1907): 174–180, 199–208. **Verrier.**

Les populations sauvages de l'Etat de Bahia. Par Dr. G. Verrier. *With Portrait and Illustrations.*

Brazil—Rio de Janeiro. *Rev. I. Hist. e G. Brazileiro* **67** (1906): Part 2, 263–396. **Silva.**

Chorographia Fluminense (O Estado do Rio de Janeiro em 1896). Por Antonio José Caetano da Silva.

Chile—Andes. *C.R.A. Sc. Paris* **145** (1907): 314–317. **Schrader.**

Détermination de l'altitude du sommet de l'Aconcagua (Cordillère des Andes). Par Fr. Schrader.

M. Schrader places the height at 22,812 feet, as against the 23,080 of Mr. Fitz-Gerald's expedition, to which he makes no reference. See February number, p. 221.

Chile—Phytogeography. **Reiche.**

Die Vegetation der Erde: Sammlung pflanzengeographischer Monographien, herausgegeben von A. Engler and O. Drude. VIII. Grundzüge der Pflanzenverbreitung in Chile, von Dr. Karl Reiche. Leipzig: W. Engelmann, 1907. Size 10 × 7, pp. xiv. and 374. *Maps and Illustrations. Price* 20*m.*

Ecuador—Archæology. **Saville.**

Contributions to South American Archeology: the George G. Heye expedition. (Vol. 1.) The antiquities of Manabi, Ecuador. A preliminary report. By Marshall H. Saville. Size 13 × 9½, pp. viii. and 136. *Illustrations. Presented by the Author and George G. Heye, Esq.*

Peru—Historical. **Markham.**

History of the Incas. By Pedro Sarmiento de Gamboa; and The Execution of the Inca Tupac Amaru, by Captain Baltasar de Ocampo. Translated and edited by Sir Clements Markham. (Hakluyt Society Publications, Second series, No. xxiii.) Cambridge, 1907. Size 9 × 5½, pp. xxii. and 396. *Map and Facsimile Illustrations. Presented by the Hakluyt Society.*

Tierra del Fuego. **Crawshay.**

The birds of Tierra del Fuego. By Captain Richard Crawshay. London: B. Quaritch, 1907. Size 11½ × 7½, pp. xl. and 158 *Map and Illustrations. Presented by the Author.*

This splendidly illustrated work will be reviewed elsewhere.

AUSTRALASIA AND PACIFIC ISLANDS.

New Guinea—Dutch. *Ts. K. Nederlandsch Aardr. Genoots.* **24** (1907): 547–631. **Hille.**

Reizen in West-Nieuw-Guinea. III. Door J. W. van Hille, waarnemend Assistant-Resident van West-Nieuw-Guinea. *With Map.*

New Guinea—Dutch. **Hellwig.**

Ts. K. Nederlandsch Aardrijksk. Genoots. **24** (1907): 845–854.

Exploraties aan de Zuidwestkust van Nieuw-Guinea. Door R. L. A. Hellwig.

New Guinea—Ethnology. **Pöch.**

Reisen in New Guinea in den Jahren 1904–06. Von Rudolf Pöch. (Aus der *Zeitschrift für Ethnologie*, Heft 3, 1907). Size 9½ × 6½, pp. 382–400. *Illustrations.*

See account of Dr. Pöch's journeys in the December number.

New Zealand—Kapiti Island. **Cockayne.**

New Zealand, 1907. Report on a botanical survey of Kapiti Island. By L. Cockayne. Size 13½ × 8½, pp. 24. *Maps and Illustrations. Presented by the Author.*

New Zealand—Surveys. **Kensington and Humphries.**

Report of the Department of Lands and Survey. New Zealand, 1906–07. By William C. Kensington and Thomas Humphries. Wellington, 1907. Size 13 × 8½, pp. (Part C. 1.) ii. and 128; (Part C. 1a) 36; (Part C. 1b) 38; and (Part C. 4) 50. *Maps, Illustrations, and Diagrams.*

Pacific Islands—Ethnology. **Macdonald.**

The Oceanic languages: their grammatical structure, vocabulary, and origin. By Dr. D. Macdonald. London: H. Frowde, 1907. Size 7½ × 5, pp. xvi. and 352. *Maps. Price* 10*s.* 6*d. net. Presented by the Publisher.*

POLAR REGIONS.

Antarctic—French Expedition.

Institut de France: Académie des Sciences. Instructions pour l'expédition antarctique organisée par le Dr. Jean Charcot. Paris, 1907. Size 6½ × 4½, pp. 48.

Arctic. *Riv. G. Italiana* **14** (1907): 492–494. **Faustini.**

Sulla opportunità di suddividere in quadranti la regione polare artica. Di A. Faustini.

Arctic—Coal. *B.S.G. Italiana* **8** (1907): 983–1005. **Faustini.**

I giacimenti di combustibili fossili nella regione artica. Note di A. Faustini. *With Maps.*

Arctic—North-West Passage. **Amundsen.**

Roald Amundsen. Die Nordwest-Passage: meine Polarfahrt auf der *Gjöa*. Munich: A. Langen, 1908 [1907]. Size 9 × 6, pp. xiv. and 544. *Maps and Illustrations. Price* 12*m. Presented by the Publisher.* [To be reviewed.]

Greenland. **Först.**

Geschichte der Entdeckung Grönlands von den ältesten Zeiten bis zum Anfang des 19. Jahrhunderts. Inaugural-Dissertation . . . von Johannes Forst. Worms, 1906. Size 8½ × 5½, pp. 72. *Price* 1*s.* 3*d.*

A useful summary, based on the best authorities.

Polar Regions. *G.Z.* **13** (1907): 465–478. **Nordenskjöld.**

Ueber die Natur der Polarländer. Von Otto Nordenskjöld.

MATHEMATICAL GEOGRAPHY.

Cartography. *B.S.G. Italiana* **8** (1907): 785–795. **Crema.**

Carte topografiche stereoscopiche. Nota del tenente C. F. Crema. *With Diagrams.*

Discusses the possibility of obtaining a stereoscopic effect by the use of specially prepared maps and apparatus.

Cartography. *Z. Ges. E. Berlin* (1907): 539–555. **Eckert.**

Die Kartographie als Wissenschaft. Von Prof. Dr. Max Eckert.

Cartography—Methods. *M. k.k. militärg. I.* **26** (1906): 172–176. **Glotz.**

Ueber Reproduktion lavierter Terrainzeichnungen. Von Wilhelm Glotz. *With Map.*

On mechanical methods of reproducing relief-shading done by brushwork.

Cartography—Projections. *B.S.R.G. Anvers* **31** (1907): 65–94. **Duchesne.**

L'enseignement des projections cartographiques. Par Charles Duchesne. *With Diagrams.*

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Climatology. *Meteorologische Z.* **24** (1907): 433–444. **Knoche.**

Die äquivalente Temperatur ein einheitlicher Ausdruck der klimatischen Faktoren "Lufttemperatur" und "Luftfeuchtigkeit." Von Walter Knoche. *Diagrams.*

"Equivalent temperature" is a term invented by Herr von Bezold to combine the factors of temperature and humidity, and is recommended by the writer as the best criterion of varieties of climate. His view has since been contested by Dr. J. Hann.

Geological History. *Naturw. Wochenschrift* **22** (1907): 673–679. **Arldt.**

Zur Atlantisfrage. Von Dr. Th. Arldt. *Map.*

Geology. **Haug.**

Émile Haug. Traité de géologie. I. Les phénomènes géologiques. Paris: A. Colin, 1907. Size 10 × 6½, pp. 546. *Maps, Illustrations, and Diagrams. Price* 12 *fr.* 50. *Presented by the Publisher.*

Geology—Loess. *Z. Ges. E. Berlin* (1907): 374–377. **Rühl.**

Ueber die ungleichseitige Verbreitung der Löss an den Talgehängen. Von Dr. Alfred Rühl.

Geology—Soils. **Schwarz.**

Agricultural geology. By Prof. E. H. L. Schwarz. [Reprinted from the *Natal Agricultural Journal*, vol. **10**, No. 8. 1907.] Size 10 × 6, pp. 14.

Among other points emphasized is the importance of bacteria in preparing the soil for the support of plant-life.

Geomorphology. *Beiträge Geophysik* **9** (1907): 78–95. **Arldt.**

Die antipodische Lage von Land und Meer. Von Dr. Th. Arldt. *With Map.*

Geomorphology. *G. Anzeiger* **8** (1907): 176–178, 197–199. **Arldt.**

Verschwundene Inseln und versunkene Kontinente. Von Dr. Th. Arldt.

Geomorphology. *J. Geology* **15** (1907): 560–570. **Arnold.**

Dome structure in conglomerate. By Ralph Arnold. *With Illustrations.*

Geomorphology—Dunes. **Günther.**

Sitzungsber. math.-phys. Kl. A.W. München (1907): 139–153.

Ein naturmodell der Dünenbildung. Von Siegmund Günther. *With Diagrams.*

Geomorphology—Steppes. *Naturw. Wochenschrift* **22** (1907): 705–707. **Gessert.**

Unterschiede des Bodens in Steppen verschiedener Klimate. Von Ferdinand Gessert.

Geophysics. **Darwin.**

Scientific papers. By Sir George Howard Darwin. Vol. 1, Oceanic tides and lunar disturbance of gravity. Cambridge: University Press, 1907. Size 10½ × 7, pp. xiv. and 464. *Diagrams. Price 15s. net. Presented by the Publishers.*

Seismology. **Hobbs.**

Earthquakes: an introduction to seismic geology. By William Herbert Hobbs. New York: D. Appleton & Co., 1907. Size 8 × 5, pp. xxxii. and 336. *Maps, Illustrations, and Diagrams. Price $2 net. Presented by the Publishers.* [To be reviewed.]

Seismology. **Montessus de Ballore.**

Comte de Montessus de Ballore. La science seismologique. Les tremblements de terre. Paris: A. Colin, 1907. Size 10 × 6¼, pp. viii. and 580. *Maps, Illustrations, and Diagrams. Price 16 fr. Presented by the Publisher.* [To be reviewed.]

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropogeography. *B. American G.S.* **39** (1907): 383–397, 449–463. **Semple.**

Geographical boundaries. By Ellen Churchill Semple.

Noticed in the Monthly Record, January, p. 109.

Anthropogeography. *G.Z.* **13** (1907): 505–517. **Schlüter.**

Ueber das Verhältnis von Natur und Mensch in der Anthropogeographie. Von Otto Schlüter.

Anthropogeography—Commerce. **Speck.**

Handelsgeschichte des Altertums. Von E. Speck. 3 vols. I. Die orientalischen Völker (pp. viii. and 592); II. Die Griechen (pp. viii. and 582): III., 1. Hälfte. Die Karthager, u.s.w. (pp. viii. and 536); III., 2. Hälfte. Die Römer (pp. iv. and 1154). Leipzig: F. Brandstetter, 1900–1906. Size 8½ × 6. *Price 35m.*

Commercial.

Tables showing the progress of merchant shipping in the United Kingdom and the principal maritime countries [to the year 1906]. London, 1907. Size 13 × 8½, pp. 88.

Commercial. **Day.**

A history of Commerce. By Clive Day. New York & London: Longmans & Co., 1907. Size 8 × 5¼, pp. xliv. and 626. *Maps. Price 7s. 6d. net. Presented by the Publishers.* [To be reviewed.]

Commercial. **Friedrich.**

Allgemeine und spezielle Wirtschaftsgeographie. Von Dr. Ernst Friedrich. Zweite Auflage. Leipzig: G. J. Göschen, 1907. Size 9 × 6, pp. 468. *Maps. Price 6m. 80. Presented by the Publishers.*

The first edition was reviewed in vol. 24, p. 581. The work has now been revised and extended.

Commercial—Shipping. **Almeida.**

Le centenaire de la navigation à vapeur et l'Exposition Maritime de Bordeaux. Par P. Camena d'Almeida, Bordeaux, 1907. Size 10½ × 7, pp. 36.

Historical. **Beazley.**

Directorium ad faciendum passagium transmarinum. Edited by C. Raymond

Beazley. (Reprinted from the *American Historical Review*, vol. 12, No. 4, and vol. 13, No. 1, July and October, 1907.) Size 10½ × 7, pp. 810–857 and 66–115. *Presented by the Editor.* [See note at p. 342, *ante*.]

Historical—Ibn Jubayr. **Wright.**

The travels of Ibn Jubayr, edited from a manuscript in the University Library of Leydon by William Wright. 2nd edition, revised by M. J. de Goeje. [Arabic text and notes only.] Leyden: E. J. Brill; London: Luzac & Co., 1907. Size 10 × 6, pp. 53 and 363. *Presented by the E. J. W. Gibb Memorial Trustees.*

BIOGRAPHY.

Bòttego. *B.S.G. Italiana*, iv. 8 (1907): 1075–1088. **Millosevich.**

Commemorazione di Vittorio Bòttego letta a Parma il 26 Settembre, 1907. Dal Prof. Elia Millosevich. *Portrait and Illustration.*

Bòttego. *Riv. Col.* 4 (1907): 175–199. **Mori.**

L'opera di Vittorio Bòttego. Del Dott. Angiolo Mori. *Illustration.*

Buchan. *Symons Met. Mag.* 42 (1907): 103–106. ——

Alexander Buchan. 1829–1907.

Diaz. ——

Porfirio Diaz and his work. By a soldier of the Old Guard. Mexico, 1907. Size 8½ × 5½, pp. 128. *Plan and Illustrations.*

GENERAL.

Educational. **Mackinder.**

The development of geographical teaching out of nature study. An address by H. J. Mackinder. London: G. Philip & Son, 1908. Size 9½ × 6½, pp. 16. *Presented by the Publishers.*

Geography—Text-book. **Mill.**

The International Geography. By seventy authors. Edited by Dr. Hugh Robert Mill. [4th edit.] London: Macmillan & Co., 1907. Size 8½ × 5½, pp. xx. and 1088. *Maps, Illustrations, Diagrams, etc. Price* 15*s. Presented by the Publishers.*

This work has again been revised and brought up to date for its issue by Macmillan & Co.

Geography—Text-book. **Young.**

A rational geography. By Ernest Young. Part i. London: G. Philip & Son, 1907. Size 7½ × 5, pp. xii. and 196. *Sketch-maps, Illustrations, and Diagrams. Price* 1*s.* 6*d. Presented by the Publishers.* [To be reviewed.]

Portuguese Colonies. **Negreiros.**

A. de Almada Negreiros. Les colonies portugaises. Études documentaires: produits d'exportation. Paris: A. Challamel, [*not dated*, 1906]. Size 7½ × 5, pp. 370. *Illustrations. Presented by the Author.*

Travel—Europe and Asia. **Barzini.**

Prince Scipion Borghèse. De Pekin à Paris: la moitié du monde vue d'une automobile en soixante jours. Relation de voyage par . . . Louis Barzini. Paris: Hachette et Cie., 1908 [1907]. Size 10 × 7, pp. xvi. and 448. *Maps and Illustrations. Price* 12 *fr. Presented by the Publishers.*

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

Austria-Hungary. **Freytag.**

G. Freytag's Verkehrskarte von Österreich-Ungarn mit den Balkanlandern. Scale 1:500,000 or 1 inch to 7·8 stat. miles. Vienna: G. Freytag & Berndt, 1908. *Price* 2 *kr. Presented by the Publisher.*

England and Wales. **Ordnance Survey.**

Sheets published by the Director-General of the Ordnance Survey, Southampton, from January 1 to 31, 1908.

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England—London. **Stanford.**

A new map of Metropolitan railways, tramways, and miscellaneous improvements, deposited at the London County Council, November 30, 1907, for Session 1908. Scale 1: 63,360 or 1 inch to 1 stat. mile. London: Edward Stanford, 1908. *Price*, 1*s.* 6*d.*

Europe—Central. **K. Preussische Landesaufnahme**

Topographische Specialkarte von Mittel-Europa. Herausgegeben von der kartographischen Abtheilung der K. Preussische Landesaufnahme. Scale 1: 200,000 or 1 inch to 3·1 stat. miles. Sheets: 355, Brüssel; 448, Worms; 568, Freiburg i. Br. Berlin: K. Preussiche Landesaufnahme, 1907. *Price* 1.50*m. each sheet.*

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Uebersichtskarte von Mitteleuropa. Herausgegeben von der Kartogr. Abteilung der Kgl. Preuss. Landesaufnahme. Scale 1: 300,000 or 1 inch to 4·7 stat. miles. Sheets: Aalborg; Grenaa; Hamburg; Kiel; Leeuwarden; Oldenburg. Berlin: K. Preussische Landesaufnahme, 1907. *Price* 1.50*m. each sheet.*

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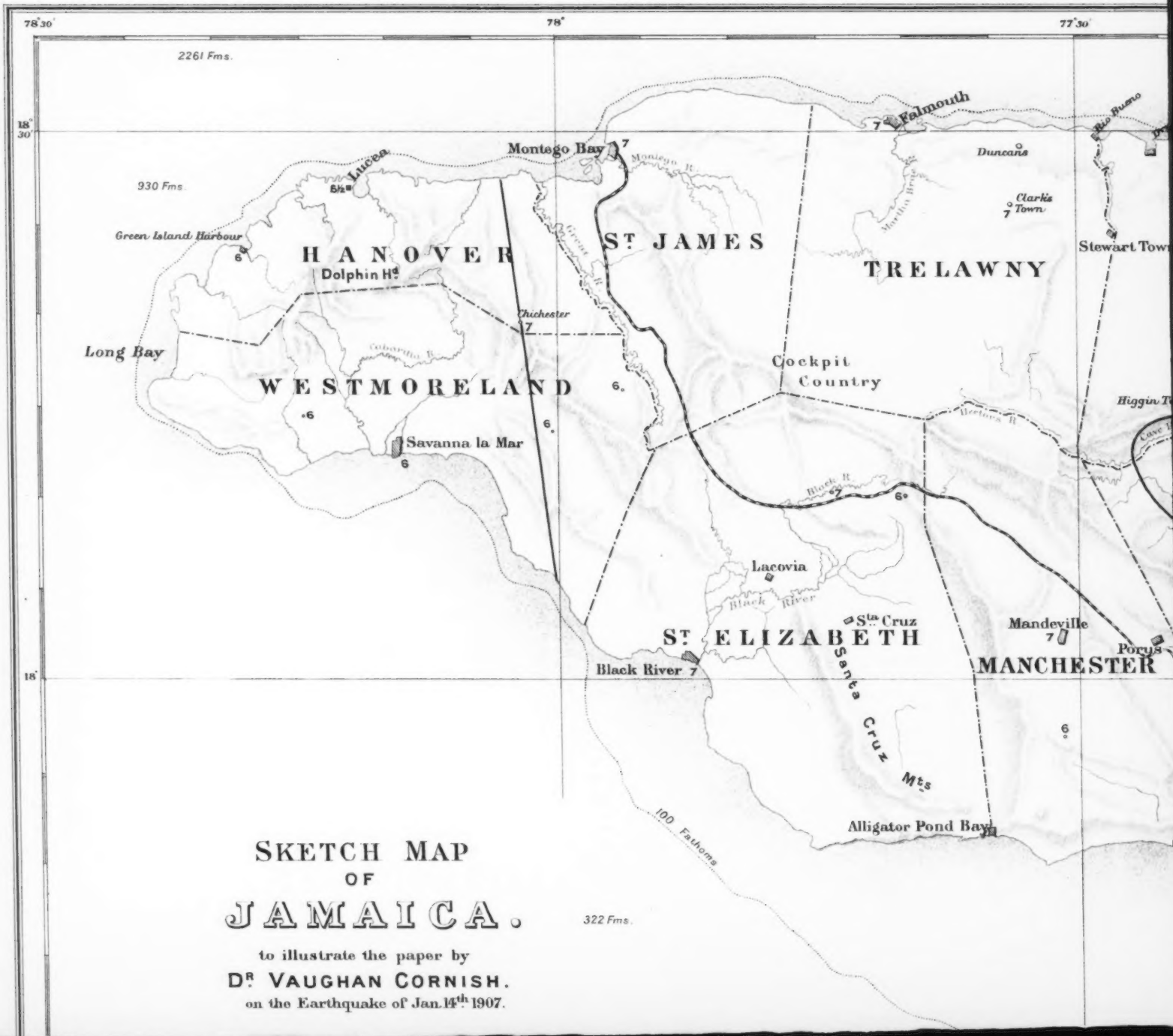
Karte des Deutschen Reiches. Herausgegeben von der Kartogr. Abteilung der Kgl. Preuss. Landesaufnahme. Scale 1: 100,000 or 1 inch to 1·6 stat. miles. Sheets: 346, Grünberg; 365, Düben. Berlin: K. Preussische Landesaufnahme. 1907. *Price*, 1.50*m. each sheet.*

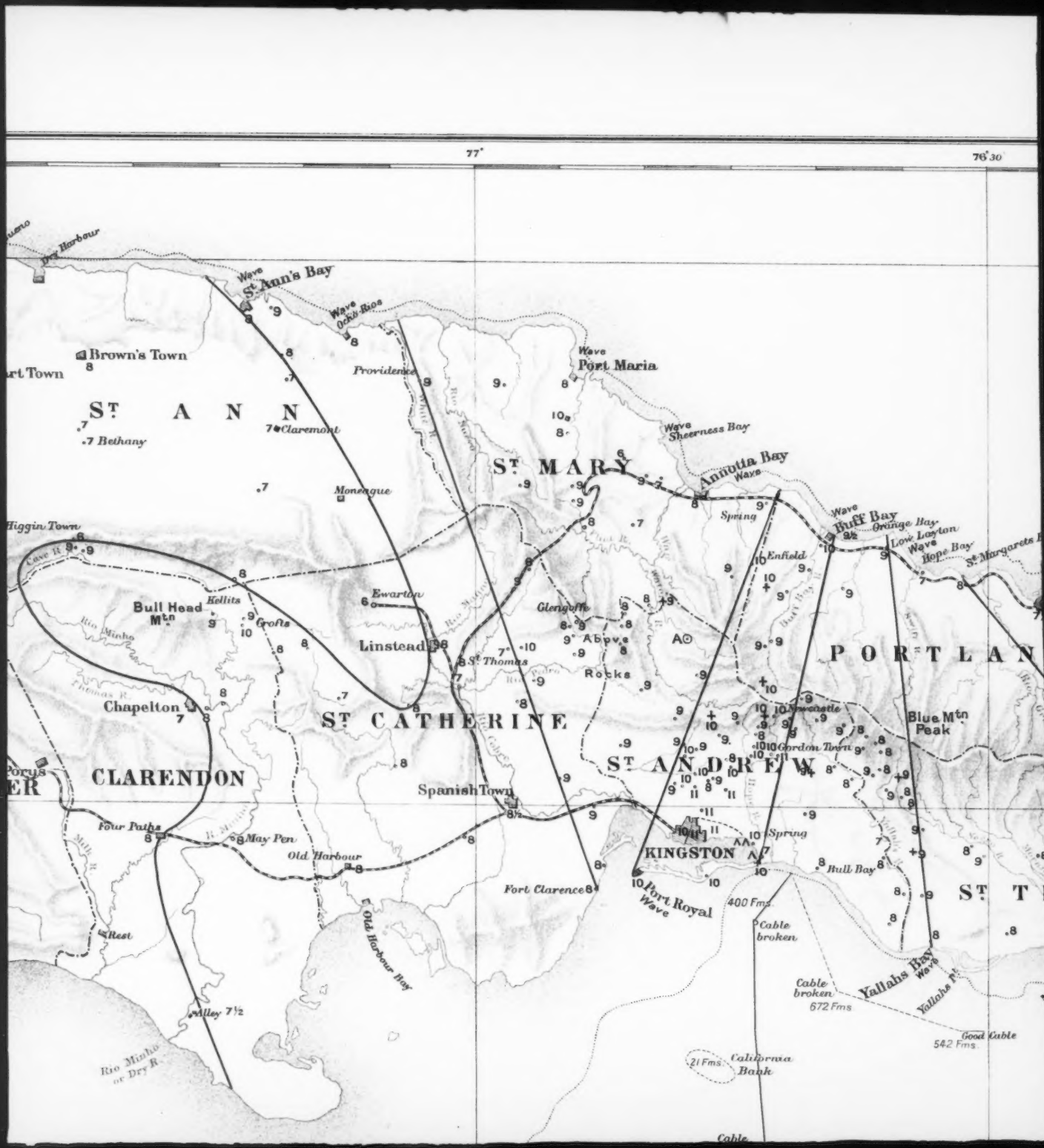


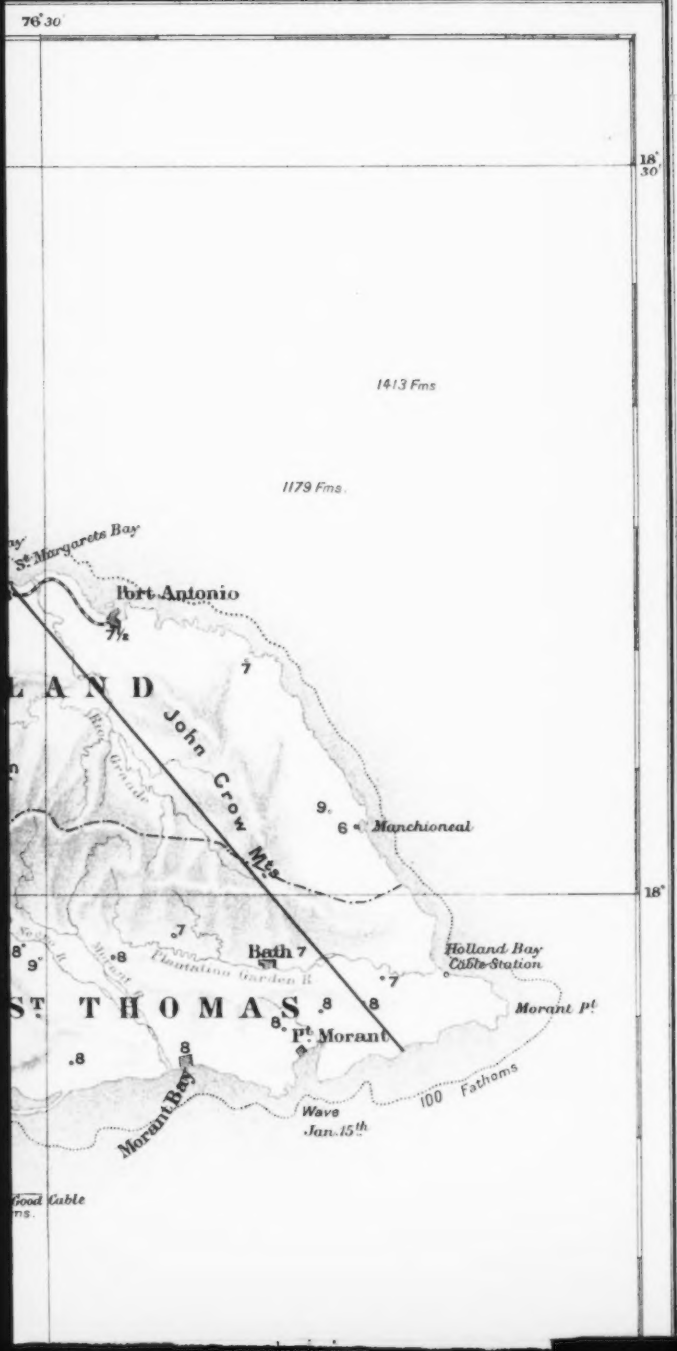
SKETCH MAP OF JAMAICA.

to illustrate the paper by

Dr. VAUGHAN CORNISH.

on the Earthquake of Jan. 14th 1907.


77°
76°30
Dry Harbour
St Ann's Bay
Wave
Ocho Rios
Brown's Town
Providence
Port Maria
ST ANN
Bethany
Claremont
Montague
ST MARY
Sheerness Bay
Annotto Bay
Spring
Buff Bay
Orange Bay
Low Layton
Hope Bay
Enfield
Higgin Town
Cave R.
Bull Head Mtn
Kellits
Ewarton
Guys
Linstead
Glengoffe
Above Rocks
St Thomas
PORTLAND
Chapelton
ST CATHERINE
Newcastle
Blue Mtn Peak
Gordon Town
ST ANDREW
CLARENDON
Spanish Town
Four Paths
May Pen
Old Harbour
KINGSTON
Bull Bay
Fort Clarence
Port Royal
400 Fms
Cable broken
Rest
Old Harbour Bay
Alley 7½
Yallahs Bay
Yallahs R.
672 Fms
Good Cable
542 Fms
21 Fms
California Bank
Rio Minho or Dry R.
Cable


76° 30'
18° 30'
1413 Fms
1179 Fms
St. Margarets Bay
Port Antonio
L A N D
John Crow Mts
Manchioneal
18°
Bath
Holland Bay
Cable Station
S T. T H O M A S
Morant Pt
Pt Morant
Morant Bay
100 Fathoms
Wave
Jan. 15th
Good Cable

to illustrate the paper by

Dr. VAUGHAN CORNISH.

on the Earthquake of Jan. 14th 1907.

Scale 1: 500,000 or 1 Inch = 7·89 Stat. Miles

5 0 5 10 15 20

Reference.

The figures thus 8, denote earthquake intensity according to the Rossi-Forel Scale.

Damaged Buildings ..... ∘

Landslip ..... +

Subsidence ..... ∧

Railways ..... ═══

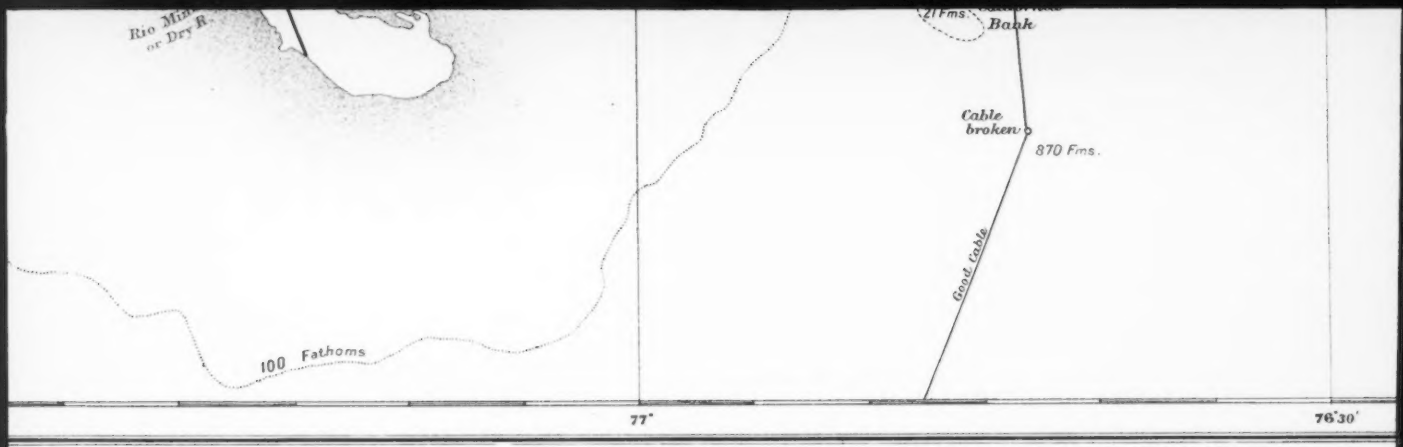
Boundaries of area of relative earthquake intensity ———

17° 30'

78° 30'

78°

77° 30

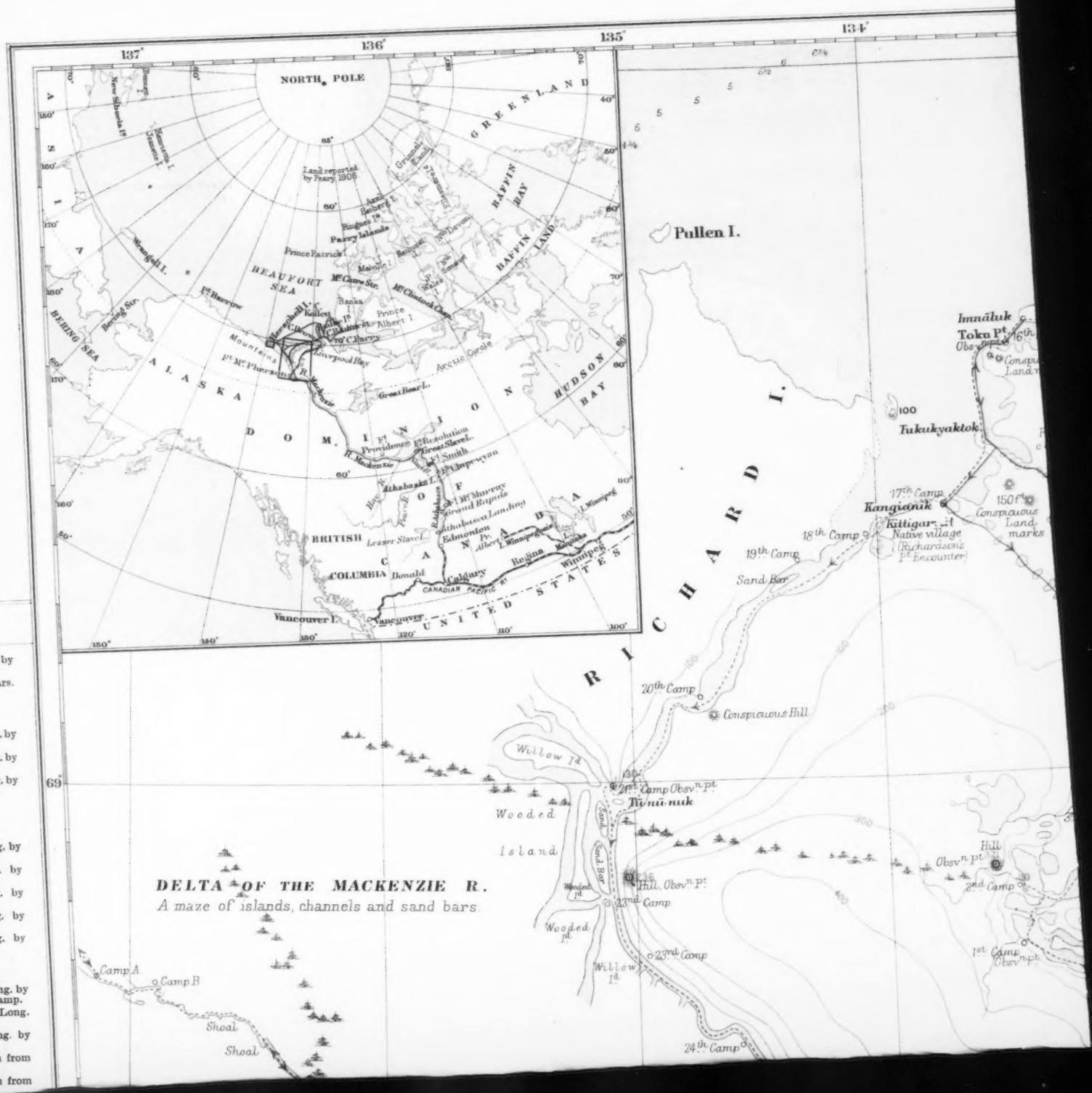


Published by the Royal Geographical Society

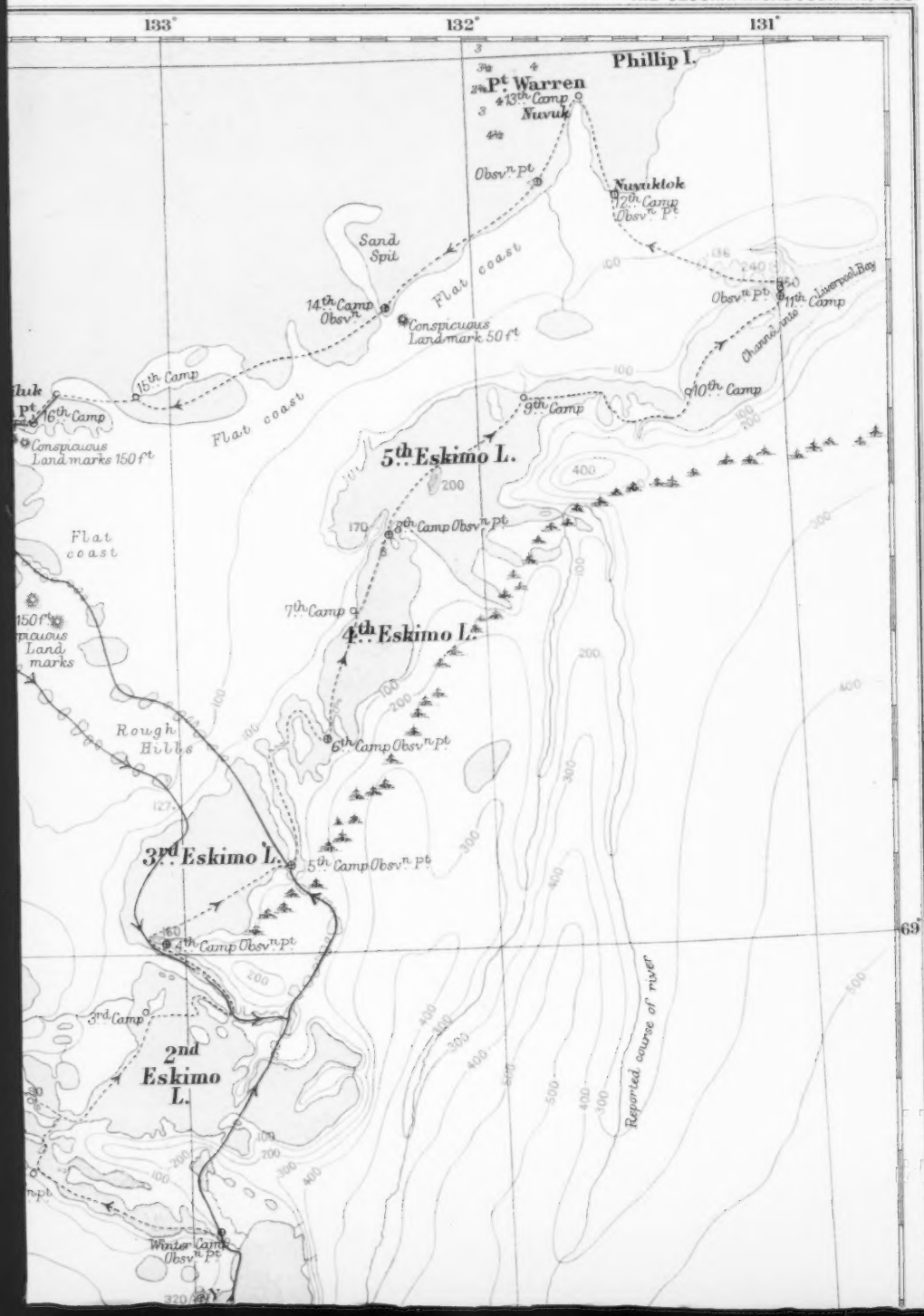
17°
30'
76°30'

List of Positions and Variation of Compass.

PLACE.	N. Lat.	W. Long.	Mag. Var. E.	REMARKS.
Mouth of Arctic Red River	67° 26′ 00″	134° 4′ 00″	46° 00′	Lat. by Circum. Mer. Sun. Long. by Chron. diff.
Fort McPherson, Peels River ...	67 25 47	135 30 00	45 30	Lat. by Circum. Mer. N. & S. Stars. Long. by Occultation.
WEST BRANCH OF MACKENZIE RIVER.				
Mouth of Peels River	67 41 00	134 58 00	45 40	Lat. by Circum. Mer. Sun. Long. by Chron. diff.
Camp G	68 7 00	135 7 00	45 30	Lat. by Circum. Mer. Sun. Long. by Chron. diff.
Camp E	68 15 00	135 35 00		Lat. by Circum. Mer. Sun. Long. by Chron. diff.
EAST BRANCH OF MACKENZIE RIVER.				
Point Separation	67 36 00			Lat. by Circum. Mer. Star.
Camp 8 Lob-sticks	67 46 00	134 42 00		Lat. by Mer. Alt. of Star. Long. by Chron. diff.
Mouth of Little River	68 3 00	134 5 00		Lat. by Circum. Sun. Long. by Chron. diff.
26th Camp	68 15 00	134 16 00	48 54	Lat. by Circum. Sun. Long. by Chron. diff.
22nd Camp	68 52 00	135 3 00	45 00	Lat. by Circum. Sun. Long. by Chron. diff.
S.W. Point of Richard I.	68 59 00	135 6 00	44 00	Lat. by Circum. Sun. Long. by Chron. diff.
THE LAKES.				
S. of Long Lake	68 11 00	133 38 00	46 25	Lat. by Double Alts. Sun. Long. by triangulation from Winter Camp.
N. of Long Lake	68 16 00	133 31 00	46 48	Lat. by Circum. Sun & Star. Long. by triangulation.
S. of Eskimo Lake	68 25 00	132 57 00		Lat. by mean of 3 obs. Long. by triangulation.
Z. West of Eskimo Lake	68 36 00	133 00 00		Lat. & Long. by triangulation from Winter Camp.
Y. West of Eskimo Lake	68 37 00	132 59 00		Lat. & Long. by triangulation from Winter Camp.



Long. by
S. Stars.
Long. by
Long. by
Long. by
Long. by
Long. by
Long. by
Long. by
Long. by
Long. by
Camp.
Long.
Long. by
ion from
ion from


133°
132°
131°
Phillip I.
Pt Warren
13th Camp
Nuvuk
Obsv.n pt
Nuvuktok
12th Camp
Obsv.n pt
Sand Spit
Flat coast
14th Camp
Obsv.n
Conspicuous Land mark 50 ft
Liverpool Bay
11th Camp
Obsv.n pt
Channel into
15th Camp
16th Camp
Conspicuous Land marks 150 ft
Flat coast
9th Camp
10th Camp
5th Eskimo L.
8th Camp Obsv.n pt
Flat coast
7th Camp
4th Eskimo L.
150 ft
Conspicuous Land marks
Rough Hills
6th Camp Obsv.n pt
3rd Eskimo L.
5th Camp Obsv.n pt
4th Camp Obsv.n pt
69°
3rd Camp
2nd Eskimo L.
Reported course of river
Winter Camp
Obsv.n pt

				Lat. by Circum. Sun. Long. by Chron. diff.

THE LAKES.

S. of Long Lake	68 11 00	133 38 00	46 25	Lat. by Double Alts. Sun. Long. by triangulation from Winter Camp.
N. of Long Lake	68 16 00	133 31 00	46 48	Lat. by Circum. Sun & Star. Long. by triangulation.
S. of Eskimo Lake	68 25 00	132 57 00		Lat. by mean of 3 obs. Long. by triangulation.
Z. West of Eskimo Lake	68 36 00	133 00 00		Lat. & Long. by triangulation from Winter Camp.
Y. West of Eskimo Lake	68 37 00	132 59 00		Lat. & Long. by triangulation from Winter Camp.
Winter Camp	68 40 49	132 54 00	47 36	Lat. by Sun and Stars mean of 4 obs. Long. by mean of 4 occultations.
2nd Camp Observation Hill	68 52 00	133 36 00	48 31	Lat. by Circum. Sun. Long. by Lat. and Az. from Winter Camp.
4th Camp „	69 00 00	133 5 00	48 49	Lat. by mean of 2 obs. Long. by Chron. diff.
5th Camp „	69 6 00	132 38 00	48 51	Lat. by Circum. Sun. Long. by Chron. diff.
6th Camp „	69 15 00	132 31 00	50 26	Lat. by Double Alts. Sun. Long. by Chron. diff.
8th Camp „	69 28 00	132 18 00	46 33	Lat. by Double Alts. Sun. Long. by Chron. diff.
11th Camp „	69 43 00	130 59 00	48 54	Lat. by Double Alt. Sun. Long. by Chron. diff.

THE ARCTIC COAST.

12th Camp, "Nuvuktok"	69 50 30	131 30 00		Lat. by Double Alt. Sun. Long. by Chron. diff.
Island between 13th and 14th Camps	69 51 00	131 46 00	48 42	Lat. by Sun mean of 2 obs. Long. by Chron. diff.
14th Camp	69 43 00	132 18 00	50 22	Lat. by Double Alt. Sun. Long. by Chron. diff.
16th Camp, Toku Point	69 36 00		46 44	Lat. by Circum. Sun.
17th Camp, "Kangianik"	69 22 00	133 44 00	47 36	Lat. by Circum. Sun (mean of 2 obs.) Long. by Chron. diff.

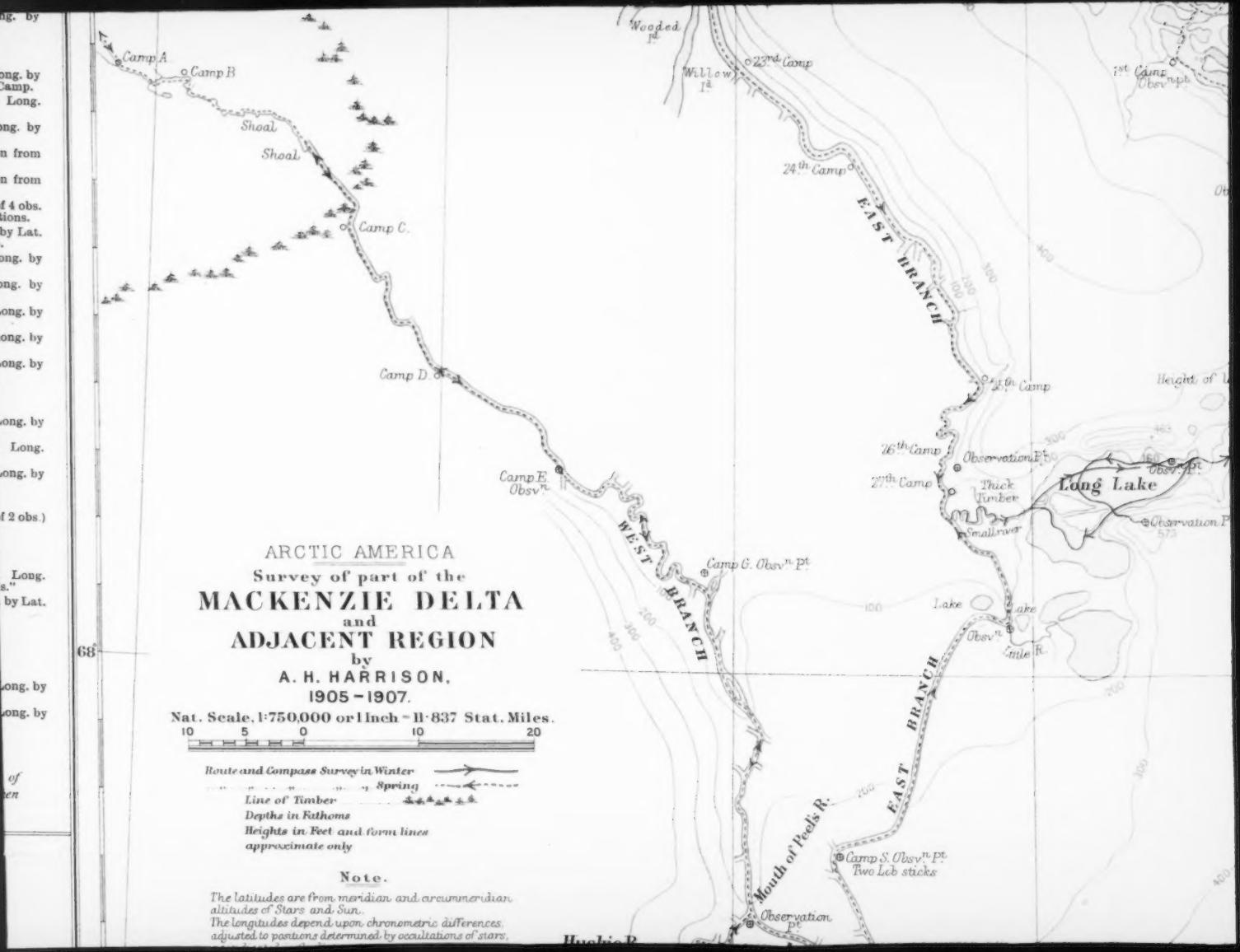
HERSCHEL ISLAND.

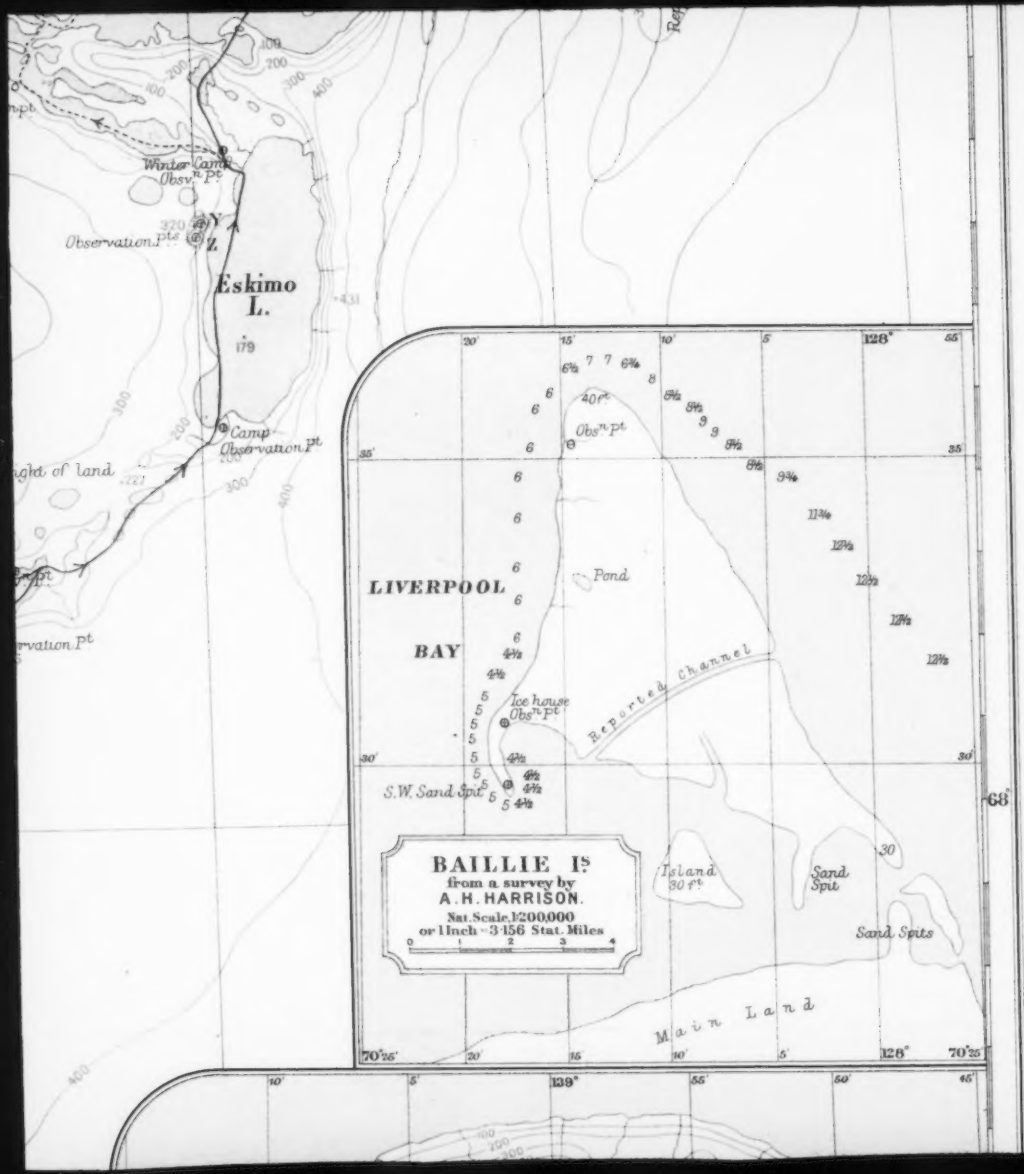
Observation Spot	69 32 48	138 57 15		Lat. by Sun mean of 3 obs. Long. by an Officer of the "Thetis."
Pauline Cove	69 34 00	138 50 38	44 26	Lat. by Circum. Sun. Long. by Lat. and Az.
S.W. Sandspit Fish Camp	69 34 00			Lat. by Mer. Alt. of Sun.

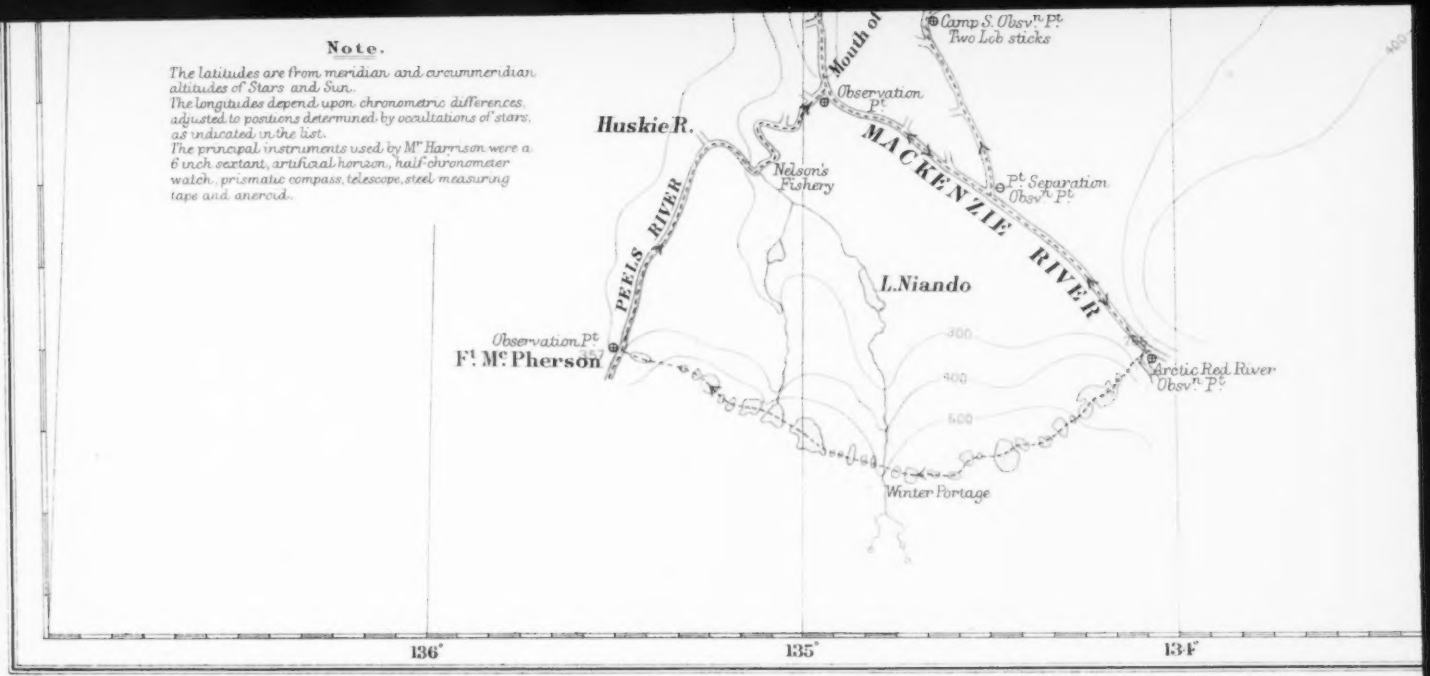
THE BAILLIE ISLANDS.

S.W. Sandspit	70 29 40	128 17 39	53 6	Lat. by Mer. Alt. of Sun. Long. by Chron. diff.
Ice Houses	70 30 36	128 18 3		Lat. by Mer. Alt. of Sun. Long. by Lat. and Az.
N.W. Corner of Island	70 35 18		52 15	Lat. by Sun mean of 2 obs.

The Variation of compass was obtained at the different stations by a comparison of prismatic compass bearings with true bearings found by astronomical observations taken with sextant and artificial horizon.

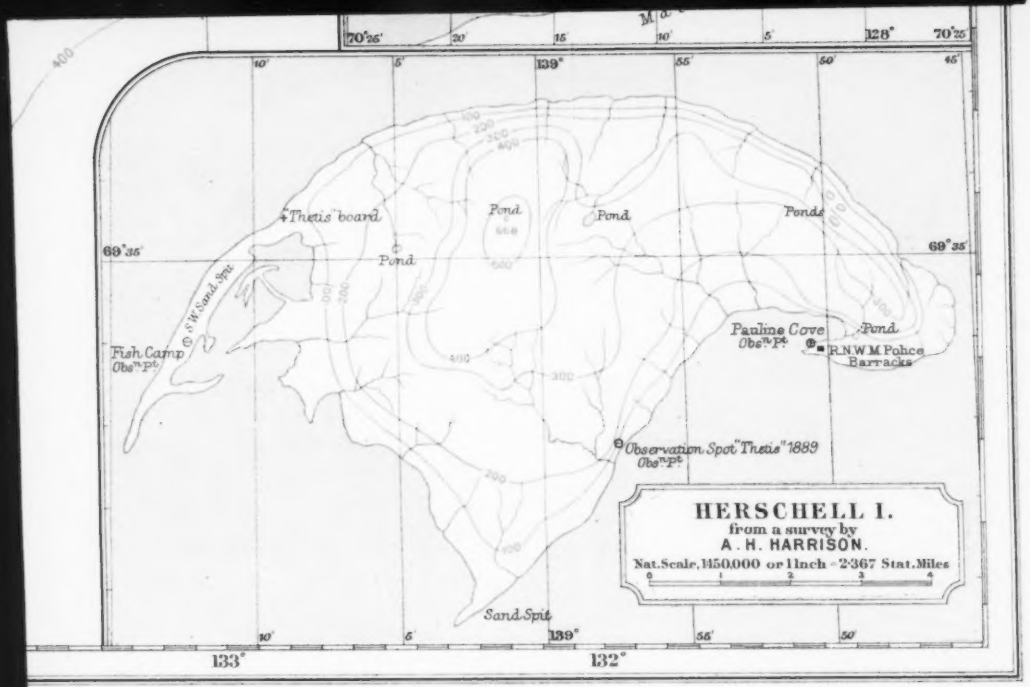

Camp A
Camp B
Shoal
Shoal
Camp C.
Camp D.
Camp E
Obsvn
Camp G. Obsvn Pt
Wooded Pt
Willow Pt
23rd Camp
24th Camp
25th Camp
26th Camp
27th Camp
Observation Pt
Thick Timber
Small river
Long Lake
Lake
Lake
Obsvn
Little R.
EAST BRANCH
WEST BRANCH
EAST BRANCH
Mouth of Peel's R.
Camp S. Obsvn Pt
Two Lob sticks
Observation Pt
68
ARCTIC AMERICA
Survey of part of the
MACKENZIE DELTA
and
ADJACENT REGION
by
A. H. HARRISON,
1905 - 1907.
Nat. Scale, 1:750,000 or 1 Inch = 11·837 Stat. Miles.
10 5 0 10 20
Route and Compass Survey in Winter
" " " " Spring
Line of Timber
Depths in Fathoms
Heights in Feet and form lines approximate only
Note.
The latitudes are from meridian and circummeridian altitudes of Stars and Sun.
The longitudes depend upon chronometric differences, adjusted to positions determined by occultations of stars,


Winter Camp
Obsv.n Pt
Observation Pts
Eskimo
L.
179
Camp
Observation Pt
ight of land
rvation Pt
LIVERPOOL
BAY
Pond
Ice house
Obsn Pt
Reported Channel
S.W. Sand Spit
BAILLIE Is
from a survey by
A. H. HARRISON.
Nat. Scale 1:200,000
or 1 inch = 3·156 Stat. Miles
0 1 2 3 4
Island
30 ft
Sand
Spit
Sand Spits
Main Land
20'
15'
10'
5'
128°
55'
35'
30'
68°
70°25'
139°
55'
50'
45'


Note.
The latitudes are from meridian and circummeridian altitudes of Stars and Sun.
The longitudes depend upon chronometric differences, adjusted to positions determined by occultations of stars, as indicated in the list.
The principal instruments used by Mr Harrison were a 6 inch sextant, artificial horizon, half chronometer watch, prismatic compass, telescope, steel measuring tape and aneroid.
Mouth of
Camp S. Obsvn Pt
Two Lob sticks
Observation Pt
Huskie R.
Nelson's Fishery
MACKENZIE RIVER
Pt. Separation Obsvn Pt
PEELS RIVER
L. Niando
Observation Pt
Ft. Mc Pherson
Arctic Red River Obsvn Pt
Winter Portage
400
300
400
500
136°
135°
134°

Conical Projection with Standard Parallels 67°35′ and 69°35′

Published by the Royal Geographical Society


70°25'
20'
15'
10'
5'
128°
70°25'
10'
5'
139°
55'
50'
45'
69°35'
69°35'
"Thetis" board
Pond
Pond
Ponds
Pond
Pauline Cove
Obs.ty Pt.
Pond
R.N.W.M. Police Barracks
Fish Camp
Obs.ty Pt.
S.W. Sand Spit
Observation Spot "Thetis" 1889
Obs.ty Pt.
HERSCHELL I.
from a survey by
A. H. HARRISON.
Nat. Scale, 1/50,000 or 1 Inch = 2·367 Stat. Miles
0 1 2 3 4
Sand Spit
10'
5'
139°
55'
50'
133°
132°

Norway. **Norges Geografiske Opmaaling.**

Topografisk Kart over Kongeriget Norge. Scale 1: 100,000 or 1 inch to 1·6 stat. mile. Sheets: K. 14, Beierdalen; S. 4, Bergsfjorden; W. 1, Nordkap; W. 7, Iskuras; 4 A, Flekkefjord; 9 B, Larvik. Christiania: Norges Geografiske Opmaaling, 1907. *Presented by the Norwegian Geographical Institute.*

Norway—Finmark. **Norges Geografiske Opmaaling.**

Kart over Finmarkens Amt. Udgivet af Norges Geografiske Opmaaling, 1907. Scale 1: 500,000 or 1 inch to 7·9 stat. miles. Christiania: Norges Geografiske Opmaaling, 1907. *Presented by the Norwegian Geographical Institute.*

ASIA.

Asia Minor. **Kiepert.**

Karte von Kleinasien. Bearbeitet von Dr. Richard Kiepert. Scale 1: 400,000 or 1 inch to 6·3 stat. miles. Sheet A. III., Zafaranboli. Berlin: Dietrich Reimer (Ernst Vohsen), [1908].

The publication of this sheet completes Dr. R. Kiepert's large and important map of Asia Minor, the first sheet of which appeared in 1902. Since no survey of the region on a systematic basis exists, the materials for the construction of the map consist chiefly of route traverses and sketches of varying merit, adjusted here and there to positions which have been determined astronomically with more or less accuracy. Admiralty charts serve for the delineation of the coast-line, and occasionally a fairly accurate survey, such as that for the line of railway, furnishes reliable data for a limited area; but with these exceptions the cartographical material is rough and conflicting, and to construct anything like a satisfactory map on a large scale at the present time is no light undertaking. However, Dr. R. Kiepert has had many advantages, not the least being that he is in possession of the great mass of material collected by his father, the late Dr. H. Kiepert, from his own surveys and other sources, some of which were published in his map of Asia Minor as long ago as 1844. Availing himself of these and other sources of information, the author has been able to produce a most creditable map, which, if not altogether correct in parts, contains most valuable information, and is far more complete in detail than any other hitherto published. The labour involved in the compilation must have been enormous, and it is hoped that the sheets will be kept up to date and corrected as fresh information is forthcoming and errors in place-names and topography are detected. The map is in twenty-four sheets, each measuring 19 × 24 inches, and is well executed. Hills are shown by brown shading. Parts mapped from material taken from Turkish and Greek authorities, and all ancient names, are distinguished by the style of lettering.

India. **Joppen.**

Historical atlas of India for the use of High Schools, Colleges, and Private Students. By Charles Joppen, S.J. London: Longmans, Green, & Co., 1907. *Price 3s. net. Presented by the Publisher.*

This useful little atlas contains a series of twenty-six coloured maps of India, printed at the establishment of Justus Perthes, Gotha, which will enable a student to follow the leading events connected with the history of India from the earliest times. Sixteen pages of text, dealing with leading historical facts and data, are given at the commencement of the atlas, which should be studied in connection with the maps. The atlas is intended for school and college students, and no attempt has been made to furnish a set of detailed maps for the use of mature scholars. The following is a list of the maps:—

Alexander's Empire, 326 B.C.; India in the Second Century A.D.; India in 350 A.D.; The Empire of the White Huns in the Beginning of the Sixth Century A.D.; India in the Seventh Century A.D.; India in 1022; India in 1236; India in 1318; India in 1398; India in 1525; India in 1605; India in 1700. To illustrate the Early Mahratta History: Mysore, the Dominions of Chick Deo Raja Wadeyar, 1704. To illustrate the wars between the English and French in the Carnatic: India in 1751; Hyder's Dominions in 1780. To illustrate the four Mysore wars (1784): India in 1795; India in 1805; India in 1823; India in 1848; India in 1856. The Growth of British Bengal and Burma; The Indian Empire in 1907 A.D.

AFRICA.

Abyssinia. **Bieber.**

West-Gallaland. Routen der Expedition v. Mylius-Bieber (Adis Ababa-Dschirren), 1905. Aufgenommen von Friedrich J. Bieber. Scale 1: 250,000 or 1 inch to 3·9 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1908, Tafeln 1. u. 2. Gotha: Justus Perthes, 1908. *Presented by the Publisher.*

The route followed by the Mylius-Bieber expedition was due south from Adis Ababa for about 40 miles, thence west and south-west for about another 140 miles to Jiren and the Didessa river. The map is from a route survey by Herr F. J. Bieber, and accompanies his account of the expedition given in *Petermanns Mitteilungen* for January last. No attempt has been made to show latitudes and longitudes.

Africa. **Topographical Section, General Staff.**

Map of Africa. Compiled in the Topographical Section, General Staff. Scale 1 : 250,000 or 1 inch to 3·9 stat. miles. (Provisional) Sheets: 17–D and J, El Arish; 17–I and part of C, Port Said; 17–K and part of E, Rafah; 17–L and part of F, Mt. Hor; 17–O, Suez; 17–P, Nakhl; 17–Q, Wadi Taba; 17–R, Akaba. London: Topographical Section, General Staff, War Office, 1907. *Price* 1*s.* 6*d. each sheet. Presented by the Director of Military Operations.*

Egypt. **Survey Department, Cairo.**

Topographical map of Fayum Province. Scale 1 : 10,000 or 6·3 inches to 1 stat. mile. Sheets: S.E. 12–2, 13–1, 15–1, 17–1. S.W. 13–9, 14–1, 14–13, 15–1, 17–1, 17–2, 17–3, 17–4, 17–5, 17–6, 17–7, 17–9, 17–10, 17–11, 18–1, 18–2, 18–3, 18–4, 18–5, 18–6, 18–9, 19–1, 19–2, 19–3, 19–4, 19–5, 19–9, 20–2, 20–9. Topographical map of Qalinbia Province. Scale 1 : 10,000 or 6·3 inches to 1 stat. mile. Sheets: N.E. 5–4, 6–4, 6–5, 6–6, 9–3. Cairo: Survey Department, 1907. *Presented by the Director-General, Survey Department, Cairo.*

Gold Coast. **Guggisberg.**

Map of the Gold Coast. Published by the authority of Sir John Pickersgill Rodger, K.C.M.G., Governor, under the direction of Major F. G. Guggisberg, R.E., F.R.G.S., Director of Surveys, Gold Coast. Scale: 1 : 125,000 or 1 inch to 1·9 stat. mile. Sheets: 72 K. IV. Fumso; 72 Q. II. Prahsu (Praso). Edinburgh and London: W. & A. K. Johnston, 1907. *Price* 2*s. each sheet. Presented by Major F. G. Guggisberg,* R.E., *Director of Surveys, Gold Coast.*

Transvaal. **Geological Survey.**

Transvaal Geological Survey. Scale 1 : 150,000 or 1 inch to 2·4 stat. miles. Sheet 1, Pretoria. With Explanation. Pretoria: Government Printing and Stationery Office, 1907. *Presented by the Director, Geological Survey of the Transvaal.*

This is the first sheet of the Geological Survey of the Transvaal, and includes an area of about 2200 square miles around Pretoria. The geological work was done between the years 1903 to 1906 by Messrs. H. Kynaston, E. T. Mellor, and A. L. Hall, supplemented by that of Mr. F. A. Steart in the immediate neighbourhood of Pretoria. The sheet is well printed in colours, and is accompanied by a descriptive pamphlet by Mr. H. Kynaston, B.A., F.G.S., the director of the survey.

AMERICA.

Chile. **Oficina de Limites, Santiago.**

Comision Chilena de Limites. Scale 1 : 250,000 or 1 inch to 3·9 stat. miles. Sheets: Antofagasta; Atacama. Santiago: Oficina de Limites, [1907]. *Presented by the Oficina de Limites, Santiago.*

The topographical sheets include the Andine boundary region between 22° and 23° S. and 25° and 26° S. Those showing the lines of traverse and triangulation include the same latitude, but in longitude extend from 66°20′ to 67°50′ W. and 66°50′ to 69°10′ W.

Mexico. **Secretaria de Comunicaciones y Obras Publicas.**

Carta de Ferrocarriles de los Estados Unidos Mexicanos. Scale 1 : 2,000,000 or 1 inch to 31·5 stat. miles. 2 sheets. Mexico: Secretaria de Comunicaciones y Obras Publicas, [1907].

A blue-print of an official map by the Secretary of Communications and Public Works of Mexico, showing railways up to date. Principal towns are given, but no hill work, so that, although somewhat rough in execution, the map is fairly clear.

GENERAL.

World. **Harmsworth.**

Harmsworth Atlas and Gazetteer. Parts 33 & 34. London: The Amalgamated Press, Limited, [1908]. *Price 7d. each part.*

These parts contain the following maps:—Part 33: Nos. 111–112, Persia and the Afghan Frontier; 151–152, Rhodesia and British Central Africa; 175–176, Central United States.—Part 34: Nos. 137–138, French North Africa and Morocco; 177–178, Western United States; 189–190, South America, North-West.

World. **Philip.**

Philip's Series of Imperial Maps: The World, showing physical features. The Polar Regions. London: George Philip & Son, [1907]. *Price 2s. 6d. each.*

These are two well-executed sheets of maps, printed in colours. They are included in the last edition of Philip's Imperial Atlas, but are also published separately at 2s. 6d. each, unmounted. The Polar Regions have been well brought up to date, and show the latest discoveries. They indicate by different colours, sea open all the year, extreme limit of drift-ice, and tundras. The other maps, showing physical phenomena, are also deserving of praise.

World. **St. Martin and Schrader.**

Atlas Universel de Géographie construit d'après les sources originales et les documents les plus récents, cartes, voyages, mémoirs. travaux géodesiques, etc., avec un texte analytique. Ouvrage commencé par M. Vivien de Saint-Martin et continué par Fr. Schrader. Sheet No. 74, Etats-Unis d'Amerique, Nord-Est. Paris: Hachette et Cie., 1908. *Presented by the Publisher.*

The first issued of a four-sheet map of the United States on the scale of 1 : 5,000,000, which will be published in this atlas. The latest materials appear to have been used in the compilation, which are mentioned in an accompanying sheet of text. Owing to the heavy and dark style in which the mountains are printed, the names in places can only be read with difficulty.

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during December, 1907. *Presented by the Hydrographer, Admiralty.*

New Charts.

No.	Inches.	
1202 m =	6·8	Scotland, west coast:—Lochs Diubaig, Grishornish, and Snizort Beg. 4*s.*
955 m =	0·35	Norway:—Inner fiords between Rövde and Molde, including Volden, Stor, and Romsdals fiords. Plans:—Nes, Sæbo, Merok. 2*s.*
3636 m =	1·9	North America, east coast, Gulf of St. Lawrence:—Restigouche river. 2*s.*
2786 m =	3·0	North America, east coast, River St. Lawrence above Quebec:—North of Lanoraie to ile Bouchard. 3*s.*
2787 m =	3·0	North America, east coast, River St. Lawrence above Quebec:—Ile Bouchard to Boucherville. 3*s.*
2426 m =	3·0	British Columbia:—Port Simpson and adjacent anchorages. 3*s.*

New Plans and Plans added.

2114 m =	5·7 11·5	Baltic entrance, The Kattegat, Plans added:—Skagen harbour, Österby harbour. 3*s.*
2732 m =	2·9	Eastern archipelago, plans of anchorages in Bali Lombok, etc. Plan added:—St. Nicholas, Banjuwedan, and Pegametan bays. 2*s.*
991 m =	2·0	Japan, anchorages on the coast of Yezo island. Plan added:—Omu road. 2*s.*
1101 m =	1·0 1·4	Mariana or Ladrone islands. New Plan:—Tanapag harbour. Plans added:—Maug islands, Assongsong island, Sarigan island. 3*s.*

Charts Cancelled.

No.	Cancelled by	No.
1202 Scotland, west coast:—Loch Snizort.	New chart. Lochs Diubaig, Grishornish and Snizort Beg	1202
2305 Norway, sheet III.:—Plans of Sæbo and Merok on this sheet. 2306 Norway, sheet IV.:—Plan of Nes on this sheet.	New chart. Inner fiords between Rövde and Molde, including Volden, Stor and Romsdals fiords. Plans:—Nes, Sæbo, Merok	955
1715 Gulf of St. Lawrence, Chaleur bay:—Plan of Dalhousie harbour on this sheet.	New chart. Restigouche river	3636

No.	Cancelled by	No.
2785 River St. Lawrence :—Lanoraie towards Contrecœur.	New chart. North of Lanoraie to ile Bouchard . .	2786
2786 River St. Lawrence :—Contrecœur to Repentigny.		
2787 River St. Lawrence :—Repentigny to Long point.	New chart. Ile Bouchard to Boucherville	2787
2426 British Columbia: Port Simpson and adjacent anchorages.	New chart. Port Simpson and adjacent anchorages .	2426

Charts that have received Important Corrections.

No. 1787, Ireland :—Wexford to Wicklow. 1772, Ireland, east coast :—Approaches to Wexford harbour. 3038, Norway :—Biörnsund to Kristiansund. 1971, Norway :—Approaches to Trondhjem, western sheet. 2368, Germany, north coast :—Jershöft to Rixhöft. 150, France :—Port and roadstead of Marseille. 1227, United States, east coast :—Boston bay and approaches. 2482, United States, east coast :—Fletcher's neck to Cape Cod. 1516, United States, east coast :—Boston harbour. 1097, Gulf of Mexico :—Caye Biscayne to lower Matacumbe bay. 3279, China, south coast :—Hong Kong waters east. 1602, China, north-east coast :—Approaches to the Yang-tse Kiang. 2924, Australia, east coast :—Cape Grafton to Hope islands. 473, Friendly islands :—Lifuka island, anchorage and approaches.
(*J. D. Potter, Agent.*)

Indian Ocean and Red Sea. **Meteorological Office.**

Monthly meteorological charts of the Indian Ocean north of 15° S. lat. and Red Sea, February, 1908. London: Meteorological Office, 1908. *Price 6d. each. Presented by the Meteorological Office.*

North Atlantic and Mediterranean. **Meteorological Office.**

Monthly meteorological charts of the North Atlantic and Mediterranean, February, 1908. London: Meteorological Office, 1908. *Price 6d. each. Presented by the Meteorological Office.*

North Atlantic. **U.S. Hydrographic Office.**

Pilot chart of the North Atlantic Ocean, January and February, 1908. Washington: U.S. Hydrographic Office, 1908. *Presented by the U.S. Hydrographic Office.*

North Pacific. **U.S. Hydrographic Office.**

Pilot chart of the North Pacific Ocean, February, 1908. Washington: U.S. Hydrographic Office, 1908. *Presented by the U.S. Hydrographic Office.*

Norway. **Norges Geografiske Opmaaling.**

Kystkarter: Generalkart A1, Skagerrak. Scale 1: 350,000 or 1 inch to 5·5 stat. miles. Specialkarter. Scale 1: 50,000 or 1·3 inch to 1 stat. mile. B 40′, Den Norske Kyst fra Froya til Gjesingen; B 55, Den Norske Kyst fra Rödö til Stott. Christiania: Norges Geografiske Opmaaling, 1907. *Presented by the Norwegian Geographical Institute.*

PHOTOGRAPHS.

British Guiana. **Anderson.**

Photograph of the Kaieteur fall, Potaro river, Essequibo, British Guiana, taken by C. Wilgress Anderson, Esq. *Presented by C. Wilgress Anderson, Esq.*

An excellent enlargement of this remarkable fall, measuring 12 inches × 14½ inches.

Himalayas.

Photograph of the Himalayas from Ranikhet. *Presented by Lieut. F. W. Parish, 60th Rifles.*

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.

RATABAN (20,094 ft.) FROM THE SLOPES ABOVE ERI UDIAR.

A. L. Mumm, Photo.